Appendix A

BALANCE SYSTEM (ARCO) WINTER DATA

The enclosed electronic file contains the collected data for the Balance system. The data are presented as one second values. The column headings are defined as:

Episode: the number of test car in the 100 car matrix

Volume; the volume of dispensed fuel to the tested vehicle

Date: the date of the tested vehicle

Time: the time of the tested vehicl;e

THC nozzle: the measured concentration of hydrocarbon vapor measured as PPM propane

THC return: the measured concentration of hydrocarbon vapor measured as PPM propane

THC vent: the measured concentration of hydrocarbon vapor measured as PPM propane

Tambient: the measured ambient temperature in Rankine units

T Nozzle: the measured nozzle temperature in Rankine units.

T Return: the measured return line temperature in Rankine units.

T Vent: the measured vent line temperature in Rankine units.

P Vent: the measured vent line pressure in inches of mercury.

P Nozzle: the measured nozzle pressure in inches of mercury.

P Return: the measured return line pressure in inches of mercury.

P Vent: the measured vent line pressure in inches of mercury.

V nozzle: the measured vapor volume in cubic feet per second

V Return: the measured vapor volume in cubic feet per second

V Vent: the measured vapor volume in cubic feet per second

Vnozzle1: the measured nozzle volume standardized to temperature and pressure conditions in scf/min units

Vreturn1: the measured return volume standardized to temperature and pressure conditions in scf/min units

Vvent1: the measured vent volume standardized to temperature and pressure conditions in scf/min units

THC nozzle mass: Hydrocarbon mass measured at the nozzle in units of pounds per minute using the Vnozzle1 and hydrocarbon data (ppm) as input parameters.

THC return mass: Hydrocarbon mass measured in the return line in units of pounds per minute using the Vreturn1 and hydrocarbon data (ppm) as input parameters.

THC vent mass: Hydrocarbon mass released from the vent line in units of pounds per minute using the Vvent1 and hydrocarbon data (ppm) as input parameters.

P UST: the pressure in the UST measured below grade in the vent line riser in inches of mercury.

PUST: the pressure in the UST in inches of water generated by the converting the inches mercury value.

P ambient: ambient pressure in inches of mercury

The methods used to derive these value are described in Section 2 of this report.

Appendix B

VACUUM ASSIST (SHELL) WINTER DATA

Appendix C

BALANCE SYSTEM (ARCO) SPRING DATA

Appendix D

BAY AREA AIR QUALITY MANAGEMENT DISTRICT PERFORMANCE DATA

Distribution:

Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

939 Ellis Street
San Francisco, California 94109
(415) 771-6000

Form 30-1
Summary of Source Test Results

Report No.: 98117
Test Date: 12/8/97
Test Times:
Run A: 1400 - 1600
Run B:
Run C:

Source Information

GDF Name and Address

ARCO #2180
3000 Travis Blvd.
Fairfield, CA 94533

GDF Representative and Title

Derek Reichart,
Arco Representative

GDF Phone No. (714) 670-5405

Source: GDF Vapor Recovery System
BAAQMD GDF # 9769
BAAQMD A/C # N/A

Permit Conditions

N/A

Facility Parameters

PHASE II SYSTEM TYPE (Check One)

Balance	X
Vapor Assist	
Type:	
Other	
Identify:	

Manifolded? (Y) or N

Operating Parameters:

Number of Nozzles Served by Tank #1	8	Number of Nozzles Served by Tank #3	4
Number of Nozzles Served by Tank #2	4	Total Number of Gas Nozzles at Facilty	16

Applicable Regualtions: CARB Contract #95-344

Test Conducted by: E. Stevenson, G. Bradbury
C. McClure, K. Kunaniec

Source Test Results and Comments:

TANK #:	1	2	3	TOTAL
1. Product Grade	87	89	92	
2. Actual Tank Capacity, gallons	11,682	11,682	11,682	35,046
3. Gasoline Volume, Gallons	2562	6,108	5,146	13,816
4. Ullage, gallons (#2 -#3)				21,230
5. Phase I System Type				Two Point
6. Initial Test Pressure, Inches H_2O (2.0)				2.00
7. Pressure After 1 Minute, Inches H_2O				1.98
8. Pressure After 2 Minutes, Inches H_2O				1.96
9. Pressure After 3 Minutes, Inches H_2O				1.94
10. Pressure After 4 Minutes, Inches H_2O				1.93
11. **Final Pressure After 5 Minutes, Inches H_2O**				1.92
12. Allowable Final Pressure from Table 30-I				1.92
13. Test Status [**Pass** or **Fail**]				Pass

Air Quality Engineer	Date	Supervisor Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson		C. McClure		K. Kunaniec	

Distribution:
- Firm
- Permit Services
- Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98116
Test Date: 12/8/97

Test Times:
Run A: 0900 - 1020
Run B:
Run C:

Source Information

Firm Name and Address:
ARCO #2180
3000 Travis Boulevard
Fairfield, CA

Permit Condition
N/A

Firm Representative and Title:
Derek Reichart,
Arco Representative
Phone No. (714) 670-5405

Source: Phase II Vapor Recovery

GDF No. 9769 Permit No.
Operates 24 hr/day & 365 days/year

BAAQMD Representatives

Source Test Team:
E. Stevenson/K. Kunaniec
G. Bradbury/C. McClure

Permit Services / Enforcement

Test Requested by:

Operating Parameters: Dispensers Tokheim 162 L-1-RC-TW
Hoses: Goodyear Premier w/Husky 3360 VR breakaways, Catlow breakaway*
Remote Vapor Check Valves: Emco Wheaton 226

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments:

NOZZLE #	GAS GRADE	NOZZLE MODEL	DYNAMIC BACK PRESSURE, INCHES H_2O		
			20 CFH	60 CFH	100 CFH
1	87	Emco Wheaton 4001	.02	.20	.54 *
2	87	Emco Wheaton 4001	.02	.18	.48
3	89	Emco Wheaton 4001	.02	.22	.58
4	92	Emco Wheaton 4001	.02	.18	.44
5	92	Emco Wheaton 4001	.02	.20	.53
6	89	Emco Wheaton 4001	.02	.18	.47 *
7	87	Emco Wheaton 4001	.04	.19	.48
8	87	Emco Wheaton 4001	.02	.20	.53
9	87	Emco Wheaton 4001	.04	.20	.65
10	87	Emco Wheaton 4001	.03	.19	.50
11	89	Emco Wheaton 4001	.04	.25	.60 *
12	92	Emco Wheaton 4001	.07	.21	.52
13	92	Emco Wheaton 4001	.05	.19	.50
14	89	Emco Wheaton 4001	.03	.16	.42 *
15	87	Emco Wheaton 4001	.04	.20	.48
16	87	Emco Wheaton 4001	.06	.24	.62

Note: Allowable Dynamic Back Pressures are 0.15, 0.45, and 0.95 at Nitrogen flowrates of 20, 60, and 100 CFH, respectively.

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson		C. McClure		K. Kunaniec	

Distribution:
- Firm
- Permit Services
- Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98125
Test Date: 12/23/97

Test Times:
Run A: 9:00 - 12:00

Source Information		BAAQMD Representatives
Firm Name and Address: ARCO #2180 3000 Travis Boulevard Fairfield, CA 94533	Firm Representative and Title: Derek Reichart, Arco Representative Phone No. (714) 670-5405	Source Test Team: E. Stevenson C. McClure
Permit Condition N/A	Source: Phase II Vapor Recovery GDF No. 9769 Permit No. Operates 24 hr/day & 365 days/year	Phase II System Type: Balance

Operating Parameters:
Number of Nozzles Served by Tank #1: 8
Number of Nozzles Served by Tank #2: 4
Number of Nozzles Served by Tank #3: 4
Total Number of Gas Nozzles at Facility: 16

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments:

TANK #:	1	2	3	TOTAL
1. Product Grade	87	89	92	
2. Actual Tank Capacity, gallons	11,682	11,682	11,682	35,046
3. Gasoline Volume, Gallons	2,009	4,669	4,505	11,183
4. Ullage, gallons (#2 -#3)				23,863
5. Phase I System Type				Two Point
6. Initial Test Pressure, Inches H_2O **(2.0)**				2.00
7. Pressure After 1 Minute, Inches H_2O				1.99
8. Pressure After 2 Minutes, Inches H_2O				1.98
9. Pressure After 3 Minutes, Inches H_2O				1.96
10. Pressure After 4 Minutes, Inches H_2O				1.94
11. **Final Pressure After 5 Minutes, Inches H_2O**				1.93
12. Allowable Final Pressure from Table 30-I				1.93
13. Test Status [**Pass** or **Fail**]				PASS

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer / Date	Supervising Air Quality Engineer / Date	Approved by Air Quality Engineering Manager / Date
E. Stevenson	C. McClure	K. Kunaniec

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Distribution:
- Firm
- Permit Services
- Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

Report No. 98126
Test Date: 12/23/97

Test Times:
Run A: 13:00 - 16:00

SUMMARY OF SOURCE TEST RESULTS

Source Information

Firm Name and Address:
ARCO #2180
3000 Travis Boulevard
Fairfield, CA 94533

Firm Representative and Title:
Derek Reichart,
Arco Representative
Phone No. (714) 670-5405

Source: Phase II Vapor Recovery

Permit Condition
N/A

GDF No. 9769 Permit No.
Operates 24 hr/day & 365 days/year

BAAQMD Representatives

Source Test Team:
E. Stevenson
C. McClure

Permit Services / Enforcement

Test Requested by:

Operating Parameters: Dispensers Tokheim 162 L-1-RC-TW
Hoses: Goodyear Premier w/Husky 3360 VR breakaways - Catlow breakaways*, Carter Industries Breakaways**
Remote Vapor Check Valves: Emco Wheaton 226

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments:

NOZZLE #	GAS GRADE	NOZZLE MODEL	DYNAMIC BACK PRESSURE, INCHES H_2O		
			20 CFH	60 CFH	100 CFH
1	87	Emco Wheaton 4001	.04	.22	.54
2	87	Emco Wheaton 4001	.06	.23	.52*
3	89	Emco Wheaton 4001	.08	.24	.58
4	92	Emco Wheaton 4001	.06	.26	.56
5	92	Emco Wheaton 4001	.05	.26	.58
6	89	Emco Wheaton 4001	.03	.18	.38
7	87	Emco Wheaton 4001	.03	.13	.34
8	87	Emco Wheaton 4001	.04	.22	.58
9	87	Emco Wheaton 4001	.07	.32	.63
10	87	Emco Wheaton 4001	.08	.26	.59
11	89	Emco Wheaton 4001	.06	.34	.78*
12	92	Emco Wheaton 4001	.04	.24	.63
13	92	Emco Wheaton 4001	.04	.22	.50
14	89	Emco Wheaton 4001	.04	.20	.36*
15	87	Emco Wheaton 4001	.03	.20	.52**
16	87	Emco Wheaton 4001	.04	.24	.66

Note: Allowable Dynamic Back Pressures are 0.15, 0.45, and 0.95 at Nitrogen flowrates of 20, 60, and 100 CFH, respectively.

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson		C. McClure		K. Kunaniec	

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674-8880

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98269
Test Date: 5/28/98

Test Times:
Run A: 10:00 – 10:50
Run B:
Run C:

Source Information

Firm Name and Address:
ARCO #2180
3000 Travis Blvd.
Fairfield, CA 94533

Permit Condition
N/A

Firm Representative and Title:
Derek Reichart
ARCO Representative
Phone No. (714) 670-5405

Source: Phase II Vapor Recovery

GDF No. 9769 Permit No.
Operates 24 hr/day & 365 days/year

BAAQMD Representatives

Source Test Team:
E. Stevenson C. McClure
G. Bradbury

Phase II System Type:
Balance - X
Vapor Assist –
Type:
Other -

Operating Parameters:
Number of Nozzles Served by Tank #1 4
Number of Nozzles Served by Tank #2 4
Number of Nozzles Served by Tank #3 4
Total Number of Gas Nozzles at Facility 16

Applicable Regulations: CARB Contract #95-344
VN Recommended: NO

Source Test Results and Comments:

TANK #:	1	2	3	TOTAL
1. Product Grade	87	89	92	
2. Actual Tank Capacity, gallons	11,682	11,682	11,682	35,046
3. Gasoline Volume, Gallons	8,546	6,316	6,108	12,424
4. Ullage, gallons (#2 -#3)				14,076
5. Phase I System Type				Two Point
6. Initial Test Pressure, Inches H_2O (2.0)				2.00
7. Pressure After 1 Minute, Inches H_2O				1.99
8. Pressure After 2 Minutes, Inches H_2O				1.96
9. Pressure After 3 Minutes, Inches H_2O				1.94
10. Pressure After 4 Minutes, Inches H_2O				1.92
11. **Final Pressure After 5 Minutes, Inches H_2O**				1.90
12. Allowable Final Pressure from Table 30-I				1.89
13. Test Status [**Pass** or **Fail**]				PASS

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson	6/1/98	C. McClure	6/1/98	K. Kunaniec	6/2/98

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98270
Test Date: 5/28/98

Test Times:
Run A: 11:30 – 2:00
Run B:
Run C:

Source Information

Firm Name and Address:
ARCO #2180
3000 Travis Blvd.
Fairfield, CA 94533

Firm Representative and Title:
Derek Reichart
ARCO Representative
Phone No. (714) 670-5405

Source: Phase II Vapor Recovery

Permit Condition
N/A

GDF No. 9769 Permit No.
Operates 24 hr/day & 365 days/year

BAAQMD Representatives

Source Test Team:
E. Stevenson
G. Bradbury
C. McClure

Permit Services / Enforcement

Test Requested by:

Operating Parameters: Dispensers: Tokheim 162L-1-PC-TW
Hoses: Goodyear Premier with Husky Breakaways
Remote Vapor Check Valves: Emco Wheaton A226

Applicable Regulations: CARB Contract 95-344 VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-27

NOZZLE #	GAS GRADE	NOZZLE MODEL	DYNAMIC BACK PRESSURE, INCHES H_2O		
			20 CFH	60 CFH	100 CFH
1	87	Emco Wheaton 4001	0.02	0.10	0.32
2	87	Emco Wheaton 4001	0.02	0.15	0.34
3	89	Emco Wheaton 4001	0.03	0.20	0.51
4	92	Emco Wheaton 4001	0.02	0.21	0.52
5	92	Emco Wheaton 4001	0.04	0.22	0.52
6	89	Emco Wheaton 4001	0.06	0.22	0.52
7	87	Emco Wheaton 4001	0.09	0.46*	1.00*
8**	87	Emco Wheaton 4001	0.04	0.20	0.50
9	87	Emco Wheaton 4001	0.05	0.26	0.63
10	87	Emco Wheaton 4001	0.05	0.24	0.58
11	89	Emco Wheaton 4001	0.04	0.22	0.54
12	92	Emco Wheaton 4001	0.04	0.23	0.53
13	92	Emco Wheaton 4001	0.02	0.22	0.53
14	89	Emco Wheaton 4001	0.05	0.21	0.48
15	87	Emco Wheaton 4001	0.05	0.23	0.50
16	87	Emco Wheaton 4001	0.05	0.20	0.49

* Within Allowable 10% Testing Error

** Catlow Breakaway

Note: Allowable Dynamic Back Pressures are 0.15, 0.45, and 0.95 at Nitrogen flowrates of 20, 60, and 100 CFH, respectively.

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson	6/1/98	C. McClure	6/1/98	K. Kunaniec	6/2/98

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98179
Test Date: 2/4/98

Test Times:
Run A: 10:00 – 10:50
Run B:
Run C:

Source Information

Firm Name and Address:
El Sobrante Shell and Food
3621 San Pablo Dam Rd.
El Sobrante, CA 94803

Firm Representative and Title:
Oyster Petroleum
Owner/Operator
Phone No. (510) 223-1445

Source: Phase II Vapor Recovery

GDF No. 1355 Permit No.
Operates 24 hr/day & 365 days/year

Permit Condition
N/A

BAAQMD Representatives

Source Test Team:
E. Stevenson C. McClure
G. Bradbury K. Kunaniec

Phase II System Type:
Balance -
Vapor Assist – Gilbarco
Type:
Other -

Operating Parameters:
Number of Nozzles Served by Tank #1: 8
Number of Nozzles Served by Tank #3: 8
Nmber of Nozzles Served by Tank #2: 8
Total Number of Gas Nozzles at Facitilty: 24

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-30

TANK #:	1	2	3	TOTAL
1. Product Grade	87	89	92	
2. Actual Tank Capacity, gallons	9,730	9,730	9,730	29,190
3. Gasoline Volume, Gallons	3,296	4,992	4,136	12,424
4. Ullage, gallons (#2 -#3)				16,766
5. Phase I System Type				Two Point
6. Initial Test Pressure, Inches H_2O **(2.0)**				2.00
7. Pressure After 1 Minute, Inches H_2O				2.00
8. Pressure After 2 Minutes, Inches H_2O				1.99
9. Pressure After 3 Minutes, Inches H_2O				1.97
10. Pressure After 4 Minutes, Inches H_2O				1.95
11. **Final Pressure After 5 Minutes, Inches H_2O**				1.93
12. Allowable Final Pressure from Table 30-I				1.93
13. Test Status [**Pass** or **Fail**]				PASS

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer / Date	Supervising Air Quality Engineer / Date	Approved by Air Quality Engineering Manager / Date
E. Stevenson	C. McClure	K. Kunaniec

Distribution:
Firm
Permit Services
Requester

BAY AREA
AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98180
Test Date: 2/4/98

Test Times:
Run A: 11:00 – 11:30
Run B:
Run C:

Source Information

Firm Name and Address:
El Sobrante Shell and Food
3621 San Pablo Dam Rd.
El Sobrante, CA 94803

Firm Representative and Title:
Oyster Petroleum
Owner/Operator
Phone No. (510) 223-1445

Source: Phase II Vapor Recovery

Permit Condition
N/A

GDF No. 1355 Permit No.
Operates 24 hr/day & 365 days/year

BAAQMD Representatives

Source Test Team:
E. Stevenson C. McClure
G. Bradbury K. Kunaniec

Phase II System Type:
Balance -
Vapor Assist – Gilbarco
Type:
Other -

Operating Parameters: Dispensers: Gilbarco AL121OC
Hoses: Goodyear Flexsteel Vapor Assist II with Husky Breakaways
Nozzles: OPW 11VA 27 and Emco Wheaton 4505

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-27

DISP. #	GAS GRADE	DYNAMIC BACK PRESSURE, INCHES H_2O 60 CFH
1 & 2	ALL	0.02
3 & 4	ALL	0.02
5 & 6	ALL	0.02
7 & 8	ALL	0.02

Note: Allowable Dynamic Back Pressures are 0.15, 0.45, and 0.95 at Nitrogen flowrates of 20, 60, and 100 CFH, respectively.

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer — Date	Supervising Air Quality Engineer — Date	Approved by Air Quality Engineering Manager — Date
E. Stevenson	C. McClure	K. Kunaniec

Distribution:
Firm
Permit Services
Requester

BAY AREA
AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98181
Test Date: 2/4/98

Test Times:
Run A: 12:30 – 3:00

Source Information

Firm Name and Address:
El Sobrante Shell and Food
3621 San Pablo Dam Rd.
El Sobrante, CA 94803

Firm Representative and Title:
Oyster Petroleum
Owner/Operator
Phone No. (510) 223-1445

Source: GDF Vapor Recovery System

Permit Condition
N/A

GDF # 1355 Application #

BAAQMD Representatives

Source Test Team:
Eric Stevenson
George Bradbury

Permit Services / Enforcement

Test Requested by:
K. Kunaniec

Operating Parameters: Dispensers: Gilbarco AL121OC
Hoses: Goodyear Flexsteel Vapor Assist II with Husky Breakaways
Nozzles: OPW 11VA 27 except where noted in serial number by –ew, then the nozzle is an Emco Wheaton 4505

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-39

Pump #	Gas Grade	Nozzle Serial #	Total Pumped gallons	Disp. Rate, gpm	Total Flow, cu ft	A-V/L	Avg. A-V/L	Pass-Fail	Roundness Pass-Fail	Comments
8	87	246564jan5	4.534	8.2	0.71	1.17		Pass	Pass	
6	87	445014aug5	4.561	7.8	0.73	1.20		Pass	Fail	
7	87	445326aug5	7.490	7.6	1.20	1.20		Pass	Pass	
5	87	445328aug6	7.498	7.8	1.18	1.18		Pass	Pass	
1	87	246057jan5	7.483	7.7	1.19	1.19		Pass	Fail	
3	87	260477feb5	7.493	8.0	0.89	0.89				
			7.511	7.9	0.91	0.91				
			7.509	7.9	0.96	0.96	0.92	Fail	Fail	
4	87	245401jan5	7.522	7.9	1.11	1.10		Pass	Fail	
2	87	24203-ew	7.492	6.6	1.07	1.07		Pass	Pass	
2	89	24202-ew	7.493	9.4	1.00	1.00		Pass	Pass	
1	89	24447-ew	7.515	9.0	1.08	1.08		Pass	Pass	
3	89	252500feb5	7.500	8.8	0.85	0.85				
			7.565	9.3	0.81	0.80				
			7.474	9.0	0.78	0.78	0.81	Fail	Fail	
4	89	260524feb5	7.507	9.2	1.09	1.09		Pass	Fail	
5	89	445329aug6	7.521	9.2	1.02	1.01		Pass	Pass	
7	89	260531feb5	7.441	8.9	1.05	1.06		Pass	Fail	
6	89	445323aug6	7.497	9.4	1.00	1.00		Pass	Pass	
8	89	252574feb5	7.514	9.4	1.21	1.20		Pass	Fail	
3	92	259743feb5	7.462	9.1	1.09	1.09		Pass	Fail	
4	92	445020aug6	7.465	8.6	1.22	1.22				
			7.577	8.9	1.20	1.18				
			7.483	8.8	1.20	1.20	1.20	Pass	Pass	
5	92	445018aug6	7.502	9.2	1.11	1.11		Pass	Pass	
7	92	292923apr5	7.531	9.2	0.71	0.71				
			7.527	8.9	0.75	0.75				
			7.464	9.1	0.75	0.75	0.73	Fail	Pass	
6	92	445827aug6	7.468	9.1	0.44	0.44		Fail		

Pump #	Gas Grade	Nozzle Serial #	Total Pumped gallons	Disp. Rate, gpm	Total Flow, cu ft	A-V/L	Avg. A-V/L	Pass-Fail	Roundness Pass-Fail	Comments
			7.062	9.4	0.43	0.46				
			7.020	9.4	0.48	0.51	0.47	Fail	Pass	
8	92	259729feb5	7.508	9.0	1.09	1.09		Pass	Fail	
2	92	24201-ew	7.468	9.1	1.04	1.04		Pass	Pass	
1	92	24448-ew	7.453	9.1	1.12	1.12		Pass	Pass	

A-V/L limits for this configuration are 1.10 to 1.20

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Results are not Official Unless Signatures Appear Below

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
E. Stevenson		C. McClure		K. Kunaniec	

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98182
Test Date: 2/17/98

Test Times:
Run A: 11:20 – 12:15
Run B:
Run C:

Source Information		BAAQMD Representatives
Firm Name and Address: El Sobrante Shell and Food 3621 San Pablo Dam Rd. El Sobrante, CA 94803	Firm Representative and Title: Oyster Petroleum Owner/Operator Phone No. (510) 223-1445	Source Test Team: E. Stevenson C. McClure G. Bradbury K. Kunaniec
Permit Condition N/A	Source: Phase II Vapor Recovery GDF No. 1355 Permit No. Operates 24 hr/day & 365 days/year	Phase II System Type: Balance - Vapor Assist – Gilbarco Type: Other -

Operating Parameters:
Number of Nozzles Served by Tank #1: 8
Nmber of Nozzles Served by Tank #2: 8
Number of Nozzles Served by Tank #3: 8
Total Number of Gas Nozzles at Facitilty: 24

Applicable Regulations:	CARB Contract #95-344	VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-30

TANK #:	1	2	3	TOTAL
1. Product Grade	87	89	92	
2. Actual Tank Capacity, gallons	9,730	9,730	9,730	29,190
3. Gasoline Volume, Gallons	6,168	3,880	2,551	12,599
4. Ullage, gallons (#2 -#3)				16,592
5. Phase I System Type				Two Point
6. Initial Test Pressure, Inches H_2O **(2.0)**				2.00
7. Pressure After 1 Minute, Inches H_2O				1.99
8. Pressure After 2 Minutes, Inches H_2O				1.97
9. Pressure After 3 Minutes, Inches H_2O				1.95
10. Pressure After 4 Minutes, Inches H_2O				1.95
11. **Final Pressure After 5 Minutes, Inches H_2O**				1.94
12. Allowable Final Pressure from Table 30-I				1.93
13. Test Status [**Pass** or **Fail**]				PASS

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer / Date	Supervising Air Quality Engineer / Date	Approved by Air Quality Engineering Manager / Date
Stevenson	C. McClure	K. Kunaniec

Distribution:
Firm
Permit Services
Requester

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 Ellis Street
San Francisco, California 94109
(415) 771-6000

SUMMARY OF SOURCE TEST RESULTS

Report No. 98184
Test Date: 2/17/98

Test Times:
Run A: 12:30 – 3:00

Source Information

Firm Name and Address:
El Sobrante Shell and Food
3621 San Pablo Dam Rd.
El Sobrante, CA 94803

Firm Representative and Title:
Oyster Petroleum
Owner/Operator
Phone No. (510) 223-1445

Source: GDF Vapor Recovery System

Permit Condition
N/A

GDF # 1355 Application #

BAAQMD Representatives

Source Test Team:
Eric Stevenson
George Bradbury

Permit Services / Enforcement

Test Requested by:
K. Kunaniec

Operating Parameters: Dispensers: Gilbarco AL121OC
Hoses: Goodyear Flexsteel Vapor Assist II with Husky Breakaways
Nozzles: OPW 11VA 27 except where noted in serial number by –ew, then the nozzle is an Emco Wheaton 4505

Applicable Regulations: CARB Contract #95-344 | VN Recommended: NO

Source Test Results and Comments: Source Test Method ST-39

Pump #	Gas Grade	Nozzle Serial #	Total Pumped gallons	Disp. Rate, gpm	Total Flow, cu ft	A-V/L	Avg. A-V/L	Pass-Fail	Roundness Pass-Fail	Comments
1	87	246057jan5	7.510	8.0	1.17	1.17		Pass	Pass	
5	87	445328aug6	7.495	7.9	1.18	1.18		Pass	Pass	
7	87	445326aug6	7.456	8.3	1.14	1.14		Pass	Pass	
4	87	245401jan5	7.500	8.3	1.18	1.18		Pass	Fail	
3	87	280477feb5	7.688	8.1	1.08	1.05		Pass	Pass	
8	87	246564jan5	7.487	8.3	1.08	1.08		Pass	Pass	
6	87	445014aug6	7.459	8.3	1.08	1.08		Pass	Fail	OPW 66CAS Breakaway
2	87	24203-ew	8.071	8.1	1.08	1.00		Pass	Pass	
3	89	252500feb5	7.590	8.8	1.02	1.01		Pass	Pass	
4	89	260524feb5	6.831	9.1	1.06	1.16		Pass	Fail	
5	89	445329aug6	7.498	9.0	1.13	1.13		Pass	Pass	
6	89	445323aug6	7.501	9.2	1.09	1.09		Pass	Pass	
7	89	260531feb5	7.522	9.0	1.09	1.08		Pass	Fail	
8	92	252547feb5	0.000	####	0.00	####		####	Pass	Shut-Off, Could Not Test
1	89	24447-ew	7.533	8.4	1.12	1.11		Pass	Pass	
2	89	24202-ew	7.509	9.2	1.04	1.04		Pass	Pass	
1	92	24449-ew	7.494	9.0	1.10	1.10		Pass	Pass	
2	92	24201-ew	7.509	9.2	1.08	1.08		Pass	Pass	
4	92	445020aug6	7.519	8.7	1.17	1.16		Pass	Fail	
3	92	259743feb5	7.496	9.2	1.03	1.03		Pass	Fail	
8	92	252574feb	0.000	####	0.00	####		####	Fail	Shut-Off, Could Not Test

Pump #	Gas Grade	Nozzle Serial #	Total Pumped gallons	Disp. Rate, gpm	Total Flow, cu ft	A-V/L	Avg. A-V/L	Pass-Fail	Roundness Pass-Fail	Comments
6	92	445827aug6	7.505	8.2	1.06	1.06		Pass	Pass	
[redacted]	92	445018aug5	7.462	9.3	1.11	1.11		Pass	Pass	
7	92	282923apr5	7.504	9.2	1.08	1.08		Pass	Pass	

A-V/L limits for this configuration are 1.00 to 1.20

NO COMMERCIAL USE OF THESE RESULTS IS AUTHORIZED

Air Quality Engineer	Date	Supervising Air Quality Engineer	Date	Approved by Air Quality Engineering Manager	Date
[redacted]tevenson		C. McClure		K. Kunaniec	

Appendix E

100 CAR TEST DATA SHEETS

ARCO Winter – Balance System

Episode	Car			Time of Fueling		Volume	Tank Temperature
	Make	Model	Year	Start	Finish	(gallons)	(°F)
1	Toyota	Camry	97	9:12	9:14	11.55	50
2	Ford	Escort	90	9:42	9:43	3.85	52.8
3	VW	Corrado	90	9:51	9:52	12.32	52.4
4	Pontiac	Grand Am	92	9:59	10:00	4.61	51.6
5	Honda	Civic	90	10:04	10:05	3.85	50.3
6	Ford	Aerostar	95	10:09	10:11	16.25	57.6
7	Cadillac	Sedan	96	10:17	10:19	15.39	63.0
8	Mercury	Sable	96	10:26	10:28	13.85	52.8
9	Chevrolet	Malibu	96	10:33	10:34	4.62	53.2
10	Ford	P/U	87	10:45	10:46	2.3	53.8
11	Mazda	626	97	12:03	12:04	7.70	65.6
12	Datsun	280Z	78	12:10	12:11	3.8	59.2
13	Ford	Aerostar	91	12:18	12:20	15.4	72.0
14	Toyota	Camry	88	12:25	12:26	4.6	65.2
15	Ford	Crown Victoria	90	12:30	12:32	15.39	66.7
16	Chevrolet	Cavalier	95	12:54	12:54	2.31	80.1
17	Ford	Escort	93	13:57	13:58	5.39	74.1
18	Toyota	P/U	93	14:03	14:04	2.31	78.0
19	Buick	LeSabre	95	14:21	14:23	13.47	77.4
20	Chevrolet	Van 30	87	14:33	14:35	15.4	78.0
21	GMC	Jimmy	97	14:43	14:44	7.7	80.8
22	Ford	Escort	95	14:49	14:50	3.85	81.5
23	Honda	Civic	79	14:58	14:59	3.08	74.1
24	Chevrolet	Blazer	84	15:01	15:03	7.69	74.3
25	Ford	F150	95	15:08	15:09	7.69	71.8
26	Toyota	Cressida	85	15:12	15:13	13.0	74.5
27	Honda	Accord	93	15:18	15:19	12.01	71.5
28	Toyota	Camry	84	15:29	15:30	7.69	78.6
29	Honda	Civic	84	15:33	15:35	7.69	70.0
30	Plymouth	Voyager	93	15:40	15:42	10.00	75.5
31	Ford	F250	76	15:45	15:48	12.00	76.8
32	Ford	Explorer	96	16:07	16:09	19.01	69.2
33	Honda	Passport	95	16:14	16:16	18.13	67.6
34	Ford	Explorer	94	16:22	16:24	15.39	69.0
35	Mazda	323	90	16:54	16:55	8.92	59.2
36	Cadillac	Brougham	87	17:06	17:08	10.15	67.0
37	Oldsmobile	Cutlass	90	17:12	17:13	3.8	59.4
38	Toyota	T100	95	17:21	17:23	5.38	57.0
39	Ford	Taurus	93	17:26	17:27	10.77	59.0
40	Infiniti	G20	96	18:26	18:28	18:29	57.0
41	Mitsubishi	Galant	96	18:37	18:38	3.80	54.0
42	Suzuki	Samurai	87	18:41	18:43	8.08	56.0
43	Buick	LaSable	88	18:50	18:52	7.69	55.0
44	Datsun	280Z	77	18:56	18:57	3.8	54.6
45	Mercury	Cougar	67	19:00	19:02	13.85	54.2
46	Buick	Century	81	19:04	19:05	6.92	55.0
47	Ford	F150	83	19:12	19:13	15.01	51.8

48	Satum	SL2	94	19:21	19:22	10.41	53.0
49	Porsche	944S	87	9:04	9:05	8.59	53.8
50	Dodge	Sportsman	78	9:20	9:22	11.55	54.8
51	Chevrolet	10 P/U	67	9:26	9:27	7.69	52.6
52	Mercury	Grandmare	84	9:30	9:31	7.69	54.2
53	Ford	Courier	78	9:37	9:39	7.69	53.0
54	Hyundai	Excel	93	9:43	9:44	5.38	54.0
55	Chevrolet	Astrovan	93	9:50	9:52	13.38	52.6
56	Honda	Prelude	93	9:55	9:57	7.69	53.1
57	Honda	Civic	91	10:06	10:08	8.40	53.2
58	Mazda	Sundowner	84	10:16	10:18	7.69	55.0
59	Chevrolet	¾ Ton	69	10:23	10:25	15.3	54.0
60	VW	Rabbit GTI	84	10:30	10:32	3.85	55.4
61	VW	Bug	69	10:35	10:36	7.85	56.0
62	Toyota	Camry	92	10:44	10:45	3.85	57.4
63	Toyota	Van	89	11:50	11:51	53.0	66.0
64	Jeep	Grand Cherokee	93	12:10	12:11	11.50	67.2
65	Acura	Integra	88	12:15	12:17	11.36	66.2
66	Chrysler	Lebaron	84	ND	ND	ND	70.0
67	Honda	Accord	92	12:23	12:25	14.05	67
68	Honda	Accord	91	12:41	12:43	15.2	73.8
69	Chevrolet	Nova	76	12:45	12:47	16.7	76.1
70	Chrysler	Sebring	96	12:55	12:57	9.78	78.0
71	Chrysler	Sebring	97	15:02	15"03	7.69	75.0
72	Chrysler	Cargo Van	93	14:23	14:25	16.12	75.0
73	Honda	Civic	87	14:28	14:29	3.84	73.0
74	Chevrolet	P/U 2500	92	14:49	14:52	17.9	78.2
75	Dodge	Caravan	86	15:05	15:06	6.16	73.1
76	Geo	Metro	96	15:24	15:25	3.65	73.2
77	Toyota	P/U	91	15:31	15:32	13.66	72.5
78	Cadillac	Coupe de Ville	88	15:40	15:41	3.80	72.3
79	Honda	CR-V	94	15:46	15:47	2.3	71.1
80	Nissan	Maxima	95	15.52	15:54	6.9	72.2
81	Ford	Tempo	88	15:57	15:58	2.20	68.0
82	Honda	Accord	84	16:03	16:04	3.85	66.0
83	Honda	Accord	87	16:18	16:19	2.31	66
84	Ford	Escort	85	16:26	16:27	6.77	66.0
85	Buick	Century	93	16:28	16:30	11.93	65
86	Oldsmobile	Cutlass	92	16:41	16:43	13.80	66
87	Nissan	Pulsar	85	17:40	17:41	4.6	59
88	Oldsmobile	Cutlass	89	17:53	17:54	3.8	60.2
89	Honda	Accord	84	18:03	18:04	3.8	60.1
90	Isuzu	Rodeo	95	18:08	18:10	11.5	56.2
91	Dodge	Caravan	90	18:15	18:16	7.69	54.2
92	Ford	F150	97	18:22	18:23	7.69	55.1
93	Dodge	Ram 50	88	18:26	18:29	3.85	55.3
94	Toyota	Tercel	91	18:28	18:29	3.08	54.6
95	Chevrolet	P/U	83	18:42	18:44	7.69	55.2
96	Ford	Festiva	88	18:46	18:47	7.69	67
97	Mercury	Topaz	84	18:55	18:56	3.89	55.0
98	Datsun	P/U	73	19:04	19:05	6.35	54.0
99	Toyota	Tercel	94	19:09	19:10	2.30	56.1

SHELL Winter – Vacuum Assist System

Episode	Car			Time of Fueling		Volume	Tank Temperature
	Make	Model	Year	Start	Finish	(gallons)	(°F)
1	Chevrolet	Van	89	3:16	3:17	7.25	57
2	Honda	CR-V	97	3:22	3:24	13.25	59
3	Ford	Van	96	3:57	3:59	6.76	63
4	Chevrolet	Impala	83	4:19	4:20	7.25	58
5	GMC	Sierra	73	4:27	4:34	21.49	58
6	Mitsubishi	Galant	88	4:46	4:48	10.8	57
7	Ford	Crown Victoria	97	5:08	5:09	5.37	57
8	Ford	Explorer	92	5:13	5:16	16.3	58
9	Dodge	Caravan	98	5:20	5:22	10.1	58
10	Buick	Regal	83	5:31	5:32	6.76	56
11	Ford	Windstar	95	5:36	5:37	18.52	58
12	Pontiac	Bonneville	94	5:51	5:53	10.15	59
13	Toyota	Corolla	94	6:05	6:07	8.27	58
14	Honda	Accord	94	6:10	6:12	5.80	58
15	Plymouth	Neon	95	6:18	6:19	4.73	58
16	Ford	Truck	79	6:30	6:32	11.24	62
17	Ford	Aerostar	87	6:35	6:37	7.25	60
18	Cadillac	Cadillac	83	7:00	7:01	3.62	57
19	Ford	Explorer	98	7:12	7:15	16.82	57
20	Plymouth	Caravelle	89	7:23	7:25	12.71	68
21	Mercury	Tracer	90	7:36	7:38	7.55	60
22	Chevrolet	Camaro	88	7:46	7:48	10.9	57
23	Honda	Accord	97	8:02	8:04	10.42	58
24	Dodge	Colt	83	9:11	9:12	7.79	56
25	Ford	Crown Victoria	97	9:22	9:23	7.39	66
26	Ford	Ranger	96	9:28	9:30	17.8	63
27	Honda	Accord	80	9:34	9:36	5.07	52
28	Chrysler	New Yorker	91	9:46	9:48	7.44	54
29	Chevrolet	4X4	96	9:51	9:54	14.5	59
30	Ford	Crown Victoria	97	9:58	10:00	12.0	65
31	Toyota	Extra Cab	91	10:07	10:08	8.2	56
32	Ford	Club Wagon	95	10:52	10:54	21.6	57
33	Ford	Econoline	74	11:00	11:02	10.62	57
34	Ford	Explorer	93	11:07	11:10	13.59	60
35	Ford	Windstar	98	11:30	11:32	16.78	57
36	Chevrolet	S-10	89	12:05	12:06	5.40	57
37	Honda	Accord	91	12:23	12:25	11.60	57
38		Sonata	89	12:28	12:30	7.25	56
39	Honda	Civic	93	12:46	12:48	7.25	57
40	Buick	LeSabre	88	1:03	1:05	14.76	58
41	Ford	Explorer	96	1:11	1:13	10.00	57
42	Nissan	Sentra	97	1:49	1:50	11.05	57
43	Ford	Club Wagon	95	1:54	1:56	13.80	56

44	Oldsmobile	Cutlass	85	2:02	2:03	9.31	58
45	Chevrolet	Custom Deluxe	83	2:14	2:16	7.25	54
46	Mitsubishi	Expo	92	2:31	2:33	5.80	57
47	Chevrolet	Silverado	84	2:37	2:39	18.41	56
48	Ford	Aerostar	86	2:54	2:56	6.76	66
49	Nissan	Altima	96	2:58	3:00	6.33	56
50	BMW	525i	92	3:07	3:09	9.49	57
51	Chevrolet	Celebrity	87	3:13	3:15	7.25	56
52	Mercedes	300E	91	3:25	3:27	6.33	59
53	Honda	Civic	83	3:55	3:57	8.44	57
54	Saturn		95	4:03	4:04	4.35	57
55	Toyota	Tercel	82	4:10	4:11	7.25	58
56	Chevrolet	S-10	94	4:18	4:19	7.25	56
57	Nissan	Sentra	85	4:25	4:26	5.80	57
58	Nissan	Quest	94	4:32	4:34	14.40	57
59	Toyota	Corrola	97	4:43	4:44	8.31	57
60	Buick	Century	84	4:48	4:52	14.36	57
61	Toyota	Camry	96	4:52	4:54	7.94	57
62	Chevrolet	Caprice	77	5:01	5:02	5.80	54
63	Chevrolet	Geo	95	5:03	5:14	7.25	56
64	Buick	Regal	83	5:19	5:20	7.25	56
65	Toyota	Tacoma	95	5:23	5:25	13.93	52
66	Acura	Legend	89	5:27	5:29	13.52	54
67	VW	Jetta	87	5:35	5:36	6.33	56
68	Cadillac	Eldorado	82	5:44	5:47	17.86	56
69	Dodge	Ram	97	6:07	6:09	8.70	57
70	Chevrolet	Tahoe	96	6:20	6:24	24.65	55
71	Isuzu	Impulse	88	6:32	6:33	3.62	56
72	Nissan	300ZX	84	10:29	10:30	5.07	54
73	Ford	P/U	74	10:40	10:42	10.14	55
74	GMC	1500	96	10:45	10:47	16.9	57
75	Honda	Accord	82	10:59	11:00	7.28	51
76	Lincoln	Continental	90	11:14	11:16	13.05	54
77	Ford	Van	95	11:19	11:22	24.47	57
78	Oldsmobile	Cutlass	96	11:27	11:29	14.15	55
79	Toyota	Camry	91	11:38	11:40	11.31	56
80	Dodge	Ram	86	11:48	11:50	15.22	54
81	Toyota	P/U	86	11:58	12:00	11.45	54
82	Nissan	King Cab	83	12:05	12:06	5.07	55
83	Ford	Explorer	91	12:21	12:23	11.6	56
84	Ford	Windstar	94	12:25	12:28	16.35	54
85	Chevrolet	Astro	95	12:32	12:34	14.5	56
86	Chevrolet	Corvette	82	12:39	12:41	16.64	56
86	Ford	Taurus	92	12:46	12:47	9.8	56
87	Dodge	Caravan	89	12:51	12:52	8.7	54
88	Ford	Probe	86	12:56	12:57	8.7	54
89	Toyota	V6	92	13:00	13:02	12.32	54
90	Cadillac	Sedan de Ville	88	13:08	13:10	10.19	54
91	Mercury	Marquis	85	13:16	13:17	7.25	53
92	Buick	Century	95	13:26	13:28	9.10	56
93	Chevrolet	Astro	97	13:31	13:33	18.02	56
94	Chevrolet	Suburban	97	13:44	13:46	14.5	56

95	Nissan	Sentra	91	13:47	13:48	5.8	56
96	Chrysler	LHS	95	13:50	13:52	12.2	57
97	Toyota	Corolla	97	14:50	14:52	8.9	56
98	Honda	Civic CRX	84	15:02	15:03	7.03	56
99	Honda	Prelude	84	15:07	15:08	7.25	58
100	Nissan	P/U	97	15:23	15:25	13.03	57
101	Chevrolet	Camaro	89	15:32	15:33	7.31	58
102	Jeep	Wranger	93	15:56	15:58	10.40	57
103	Jeep	Cherokee	86	16:14	16:16	16.12	59
104	Nissan	Sentra	96	16:37	16:39	10.51	58

ARCO Spring – Balance System

Episode	Car			Time of Fueling		Volume	Tank Temperature
	Make	Model	Year	Start	Finish	(gallons)	(°F)
1	Acura	Legend	88	9:39	9:40	9.5	60.0
2	Ford	Explorer	97	9:47	9:48	14.3	61.0
3	Ford	Taurus	94	10:02	10:03	9.5	62.0
4	Toyota	Avalon	95	10:06	10:07	7.9	59.4
5	Chevrolet	Starcraft	94	10:13	10:15	15.8	95.0
6	Mazda	626	87	10:19	10:20	2.7	60.0
7	Nissan	Sentra	87	10:25	10:26	2.3	60.0
8	Chevrolet	S10	86	10:30	10:31	7.3	60.6
9	Toyota	4 Runner	97	10:45	10:46	11.9	62.0
10	Acura	Integra	92	10:52	10:53	3.1	62.0
11	Oldsmobile	Cutlass	91	11:08	11:09	9.9	51.6
12	Ford	Mustang	98	11:21	11:22	3.9	61.4
13	Honda	Accord	94	11:29	11:30	7.9	62.4
14	Hyundai	Accent	98	11:46	11:47	7.9	62.0
15	Toyota	Camry	90	13:06	13:08	10.7	67.0
16	Ford	Expedition	97	13:18	13:20	17.2	66.4
17	Datsun	V210	81	13:42	13:43	3.9	66.2
18	Ford	Aerostar	92	13:49	13:50	7.9	66.0
19	Buick	Skylark	93	13:57	13:58	7.9	68.4
20	Honda	Civic	91	14:12	14:13	7.9	68.2
21	Nissan	P/U	83	14:20	14:21	3.4	66.2
22	Subaru	Loyale	92	14:30	14:35	13.2	67.2
23	Toyota	Previa	96	15:02	15:03	7.9	62.6
24	Honda	Accord	95	15:06	15:07	3.9	64.8
25	Toyota	Camry	93	15:12	15:14	12.0	65.8
26	KIA	Sephia	95	15:19	15:20	3.1	66.4
27	Ford	Ranger	83	15:24	15:26	15.8	66.0
28	Honda	CRV	97	15:32	15:33	9.9	65.8
29	Chevrolet	Blazer	89	15:51	15:53	14.9	66.4
30	Nissan	Quest	95	15:54	15:55	5.5	64.8
31	GMC	Sierra Classic	85	15:57	15:59	7.9	65.4
32	Toyota	4 Runner	95	16:01	16:02	4.4	66.4
33	Toyota	Camry	94	16:04	16:05	7.9	68.2
34	Chevrolet	Spectrum	86	16:09	16:10	7.1	66.8
35	Honda	Accord	87	16:15	16:16	7.9	66.0
36	Honda	Accord	94	16:22	16:23	7.9	69.0
37	GMC	Yukon	96	16:28	16:29	7.9	67.6
38	Datsun	720	82	16:42	16:44	13.5	71.6
39	Toyota	SAmry	91	16:52	16:53	5.4	70.7
40	Satum	Twin Cam	94	17:12	17:13	10.3	68.6
41	Mitsubishi	Diamonte	93	17:20	17:21	7.9	73.4
42	Nissan	Pathfinder	97	17:27	17:28	3.9	70.3
43	Honda	Civic	89	17:31	17:32	10.1	70.4
44	Dodge	Dakota	93	17:37	17:38	7.9	71.6
45	Nissan	Maxima	91	17:42	17:44	13.3	73.8
46	Honda	Civic	92	17:47	17:48	3.7	73.4
47	Honda	CRX	ND	17:55	17:56	5.7	ND

48	Chrysler	Town and Country	96	18:03	18:04	7.9	69.4
49	Ford	Taurus	95	18:07	18:08	3.9	77.6
50	Ford	Aerostar	95	18:14	18:15	7.9	75.8
51	Honda	Civic	96	18:29	18:30	9.3	ND
52	Mazda	323	88	18:37	18:39	7.9	66.4
53	Dodge	Caravan	88	18:45	18:47	16.7	65.6
54	Nissan	Stanza	87	9:20	9:21	3.1	63.6
55	Saturn		92	9:25	9:26	9.4	63.7
56	Jeep	Cherokee	88	9:30	9:31	8.7	66.0
57	Datsun	P/U	81	9:34	9:35	7.9	55.4
58	Oldsmobile	Cutlass	87	9:41	9:45	10.3	66.4
59	Honda	Accord	89	9:50	9:52	11.9	71.0
60	Toyota	T-100	96	9:58	10:00	19.8	66.4
61	Pontiac	Bonneville	94	10:03	10:05	10.1	65.0
62	Ford	Explorer	91	10:16	10:18	13.3	71.4
63	Ford	Explorer	91	10:22	10:23	5.5	69.6
64	Volvo	960	93	10:32	10:33	12.0	70.0
65	Dodge	Caravan	97	10:38	10:40	15.8	70.2
66	Toyota	Celica	92	10:48	10:49	5.5	69.2
67	Mercury	Sable	94	10:59	11:00	8.7	76.0
68	Mercury	Tracer	89	11:02	11:03	3.9	72.4
69	Toyota	Camry	89	11:10	11:12	11.6	69.4
70	Ford	Bronco	89	11:25	11:27	14.4	68.6
71	Chevrolet	Corsica	91	11:32	11:34	11.9	68.6
72	Datsun	200SX	86	11:51	11:52	7.9	72.6
73	Chevrolet	Blazer	89	13:17	13:18	3.9	77.4
74	Saturn	Coupe	93	13:27	13:29	7.9	75.6
75	Pontiac	Grand Am	89	13:36	13:37	3.1	74.8
76	Nissan	Sentra	94	13:40	13:41	3.9	81.8
77	Dodge	P/U	48	13:45	13:46	7.9	81.0
78	Pontiac	Transport	ND	13:56	13:58	14.7	77.0
79	Lexus	ES300	93	14:01	14:02	7.9	77.0
80	Nissan	300ZX	91	14:08	14:10	11.9	77.0
81	Jeep	Cherokee	87	14:18	14:19	11.9	83.0
82	Ford	Explorer	ND	14:25	14:26	10.3	77.6
83	Ford	Explorer	93	14:31	14:33	14.4	77.4
84	Nissan	240SX	90	14:35	14:36	3.9	77.4
85	Volvo	740GLE	88	14:42	14:43	7.9	83.6
86	Mercury	Cougar	95	14:53	14:55	12.9	ND
86	Ford	Ranger	94	15:00	15:01	7.9	81.4
87	Chevrolet	Silverado	95	15:05	15:06	7.9	7708
88	Nissan	Maxima	98	15:10	15:12	15.3	82.4
89	Ford	Ranger	92	15:18	15:19	13.7	79.8
90	Accura	Integra	91	16:03	16:04	9.5	86.0
91	Mercury	Sable	95	16:09	16:10	10.7	79.4
92	Chevrolet	Tahoe	86	16:15	16:17	14.6	81.4
93	Isuzu	Rodeo	94	16:29	16:31	16.5	79.2
94	Toyota	Corolla	81	16:34	16:35	7.7	77.4
95	Chevrolet	Silverado	93	16:39	16:42	22.2	79.2
96	Mercury	Mystique	98	16:50	16:51	12.6	80.2
97	Ford	Explorer	98	16:58	17:00	7.9	77.4
98	Chevrolet	Camaro	93	17:12	17:14	3.9	76.4
99	Chevrolet	Blazer	97	17:20	17:20	3.9	76.6

100	Mercury	Cougar	88	17:31	17:33	14.2	80.0

Appendix F

PROJECT QAPP

50073-B000

VAPOR RECOVERY SYSTEMS AT GASOLINE DISPENSING FACILITIES SEASONAL EFFECTS

QUALITY ASSURANCE PROJECT PLAN

Prepared for:

California Air Resources Board
1800 15th Street
Sacramento, CA 95814

November 1997

TABLE OF CONTENTS

Section		Page
1.0	INTRODUCTION	1-1
	1.1 Project Objectives	1-1
	1.2 Scope of Work	1-2
2.0	ORGANIZATION AND RESPONSIBILITY	2-1
3.0	QA OBJECTIVES FOR MEASUREMENT DATA	3-1
	3.1 Introduction	3-1
	3.2 Quality Assurance Objective for Measurement Data	3-1
4.0	MONITORING PROCEDURES	4-1
	4.1 Gasoline Dispensing Facility Site Selection Protocol	4-1
	4.2 Meteorological Measurements	4-3
	4.3 Hydrocarbon Measurements	4-3
	4.3.1 Analytical Procedures for TP-201.2	4-4
	4.3.2 Analytical Procedures for TP-201.2B	4-5
	4.3.3 Analytical Procedures for TP-201.2C	4-7
	4.3.4 Analytical Procedures for TP-201.1	4-7
	4.4 Pressure Measurements	4-8
	4.4.1 Analytical Procedures for TP-201.2	4-8
	4.4.2 Analytical Procedures for TP-201.1	4-8
	4.4.3 Analytical Procedures for UST Pressure	4-8
	4.5 Temperature Measurements	4-9
	4.5.1 Analytical Procedures for TP-201.2	4-9
	4.5.2 Analytical Procedures for TP-201.1	4-9
	4.5.3 Analytical Procedures for UST Temperature	4-9
	4.5.4 Analytical Procedures for Vehicle Tank Temperature	4-10
	4.6 Volume Measurements	4-10
	4.6.1 Analytical Procedures for TP-201.2	4-10
	4.6.2 Analytical Procedures for TP-201.1	4-11
	4.7 Other Independent Variables	4-11
	4.8 Data Acquisition Systems	4-11
	4.9 Pre-test and Post-test Measurements (Static and Dynamic Pressure and A/L Tests	4-12
	4.9.1 Analytical Procedures	4-12
	4.10 Site Operating Procedures, Quality Control Checks and Calibration	4-12
	4.10.1 Van Check Procedures	4-12
	4.10.2 Quality Control Checks and Frequency	4-14
	4.10.2.1 Zero, Span and Precision Checks - Hydrocarbons	4-14
	4.10.2.2 Temperature	4-15
	4.10.2.3 Pressure	4-15
	4.10.2.4 Volume	4-15
	4.10.3 Calibration Procedures and Frequency	4-15
	4.10.3.1 Hydrocarbon Calibration Equipment and Procedures	4-16
	4.11 Preventive Maintenance	4-16
	4.11.1 Spare Parts Policy	4-16
	4.11.2 Training	4-16

5.0 DATA REDUCTION, VALIDATION AND REPORTING 5-1
5.1 Data Base and Processing 5-1
5.2 Documentation and Data Custody 5-2
5.3 Data Validation 5-2
5.4 Field and Laboratory Procedures Used to Assess Data Accuracy Precision, and Completeness 5-3
5.4.1 Accuracy 5-3
5.4.2 Precision 5-3
5.4.3 Completeness 5-3

6.0 PERFORMANCE AND SYSTEM AUDITS 6-1
6.1 Audit Equipment 6-1
6.2 Performance Audit Procedures 6-3
6.3 System Audits 6-4

7.0 REPORTING 7-1
7.1 Data Reporting 7-1

8.0 CORRECTIVE ACTION 8-1

9.0 SCHEDULE 9-1
9.1 Study Schedule 9-1

10.0 REFERENCES 10-1

Appendices

A - TP-201.1 Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors

B - TP-201.2 Determination of Efficiency of Phase II Vapor Recovery Systems of Dispensing Facilities

C - TP-201.2A Determination of Vehicle Matrix for Phase II Vapor Recovery Systems of Dispensing Facilities

D - TP-201.2B Determination of Flow Versus Pressure for Equipment in Phase II Vapor Recovery Systems of Dispensing Facilities

E - TP-201.2C Determination of Spillage of Phase II Vapor Recovery Systems of Dispensing Facilities

SECTION 1

INTRODUCTION

The California Air Resources Board (ARB) is sponsoring a field study in Northern California. The specific test locations are located between Sacramento and the San Francisco Bay area and are scheduled to take place from fall 1997-fall 1998. The field study will include the following components:

- Field management and coordination.
- The selection and use of gasoline dispensing facilities (GDF) as field test sites.
- Existing meteorological networks.
- A field test van that will execute ARB's certification and test procedures (C & TP) for measuring hydrocarbon emissions, pressure, volume and temperature profiles from vapor recovery systems (VRS) at GDFs.
- Pressure and temperature probes that will evaluate underground storage tank temperature and pressure profiles at GDFs.
- An in-situ meteorological sampling station for ambient temperature and pressure.
- A field test van that will execute CARB's certification and test procedures (C & TP) for measuring static and dynamic pressure and air/liquid ratios for GDF vapor recovery systems.
- Quality assurance.
- Data Management.

The VRS hydrocarbon and performance test measurements are planned for five discrete time periods: fall 1997, winter 1998, spring 1998, summer 1998 and fall 1998. Each site-specific test period will take 7-14 days.

AeroVironment Environmental Services Inc., AVES, has been contracted by ARB to perform the study design, field measurement program, data processing and reporting for this program. This quality assurance project plan (QAPP) describes the measurement program to be performed by AVES.

1.1 PROJECT OBJECTIVES

This research project is designed to quantify hydrocarbon emissions at gasoline dispensing facilities (GDF) and to evaluate which variables influence the magnitude of GDF emissions. There are four objectives for this project:

1. Assess the effectiveness of balance and vacuum assist Stage II vapor recovery systems (VRS) in reducing emissions under a variety of seasonal, gasoline characteristics, and GDF conditions.

2. Identify and characterize the parameters that influence GDF emissions, develop correlations between these parameters, facility emissions and Stage II system performance, and derive a mathematical expression which relates facility emissions with the parameters that influence GDF emissions.

3. Derive emission factors for the different emittant sources at GDFs for a variety of Stage II VRS.

4. Improve the Certification and Test Procedures (C&TP) by develop a standardized methodology for determining GDF emissions and Stage II vapor recovery system efficiency.

1.2 SCOPE OF WORK

There will be two basic test conditions for this project which will be called test series: the uncontrolled test series and the controlled test series. Each test series will have unique yet related study designs. The specific elements of the controlled test series study design will depend on the results of the uncontrolled tests series.

UNCONTROLLED TEST SERIES

The uncontrolled test series is designed to evaluate the influence of a range of parameters (i.e., independent variables) on different GDF emission sources (i.e., dependent variables). The goal of this empirical evaluation is to determine which independent variables predict (i.e., account for the variance) GDF emissions. This relationship will be expressed as a mathematical expression or multivariate regression model. The specific objectives of the uncontrolled test series are therefore:

1. Quantify GDF emissions including transfer, vent line, spillage and fugitive sources for three types of VRS: uncontrolled without vapor recovery, balance and vacuum assist (Tables 1-1 and 1-2) .

2. Quantify GDF emissions including transfer, vent line, spillage and fugitive sources for three ambient temperature conditions and two types of fuel (Table 1-3) .

3. Develop correlations between VRS type emission sources and a range of independent variables that are postulated to influence emission rate and magnitude.

4. Derive emission factors in pounds/1000 gallons dispensed for the VRS type emission sources, including transfer, vent line, spillage and fugitive sources.

5. Determine the relative importance of each independent variable on the efficiency of specific VRS performance.

Based on these objectives, there will be a total of twelve field test conditions for the uncontrolled test series. The location of the GDFs is in the east San Francisco Bay area. These test locations have product throughput of no less than 100,000 gallons per month (at least 16 nozzles).

Table 1-1
Vapor Recovery System Test Conditions

Test Mode	VRS Type	Vent Valve	Assist Pump Location	Bell	Incinerator
1	None	No	N/A	No	No
2	Balance	Yes	N/A	No	No
3	Vacuum Assist	Yes	Dispenser	No	No

Table 1-2
Vapor Recovery Specifications

VRS Type	Manufacturer	Nozzle
Balance	(Executive Order 52)	Balance nozzles OPW III V or Husky V34* Emco Wheaton A4005 * - preferred
Vacuum Assist	Gilbarco VaporVac (Executive Order 150)	OPW II VAI

Table 1-3
Temperature and Fuel Type Specifications

Test Mode	Ambient Temperature	Fuel Type
1,2,3	40 ± 10° F	Winter
1,2,3	60 ± 10° F	Winter
1,2,3	60 ± 10° F	Summer
1,2,3	80 ± 10° F	Summer

Independent and Dependent Variables

Table 1-4 specifies the array of independent and dependent variables that will be measured or monitored in the field for each of the test conditions:

Table 1-4
Independent/Dependent Variables

Variable	Independent or Dependent	VRS System Type	Measurement Team
Ambient Temperature and Pressure	Independent	NBA	AVES
Site Location	Independent	NBA	AVES
Static Pressure	Independent	BA	BAAQMD
UST Temperature and Gauge Pressure	Independent	NBA	AVES
Vehicle Fuel Tank Temperature in Vapor	Independent	NBA	AVES
UST Ullage Capacity	Independent	NBA	AVES
Air/liquid Ratio	Independent	A	BAAQMD
Dynamic Back Pressure	Independent	B	BAAQMD
Station Design	Independent	NBA	AVES
Vent emissions	Dependent	NBA	AVES
Fugitive emissions	Dependent	NBA	AVES
Spillage emissions	Dependent	NBA	AVES
Bulk delivery emissions	Dependent	NBA	AVES

Where:

N = no control technology
B = Balance
A = Vacuum Assist
AVES = AeroVironment Environmental Services
BAAQMD = Bay Area Air Quality Management District

Field Tests

For each of the twelve test conditions, the independent and dependent variable data will be collected with a variety of measurement or monitoring technologies. Table 1-5 specifies the type of measurement methodology or equipment that will be used for data collection.

Table 1-5
Independent/Dependent Variables

Variable	Measurement Methodology
Ambient Temperature and Pressure	Meteorological Equipment
Site Location	Manual Recordkeeping
Static Pressure	ARB TP-201.3
UST Temperature and Gauge Pressure	Thermocouple and Pressure Transducer
Vehicle Fuel Tank Temperature in Vapor	Temperature Probe
UST Ullage Capacity	Tank Level Monitor
Air/liquid Ratio	ARB TP-201.5
Dynamic Back Pressure	ARB TP-201.4
Station Design	GDF Design Specs and Sales Data
Vent emissions	ARB TP-201.2
Fugitive emissions	ARB TP-201.2B
Spillage emissions	ARB TP-201.2C
Bulk delivery emissions	ARB TP-201.1

Where:

ARB TP-201.X = An ARB certification and test procedure

The static pressure, dynamic pressure, and air/liquid ratio tests will be executed prior to and after the collection of the other variable data to verify that the GDF VRS are operating properly. Before the field tests begin at a given GDF, the VRS manufacturer will be allowed to service the VRS to assure that it is in proper running condition before the collection of field data commences.

CONTROLLED TEST SERIES:

After completion of the uncontrolled test series, the results will be statistically analyzed to develop an optimal test design for the series of controlled independent variable tests. The optimal test design for the controlled test series provides accurate (i.e., unbiased) and precise (i.e., low variability) estimates of the effects of the independent variables The controlled test series will be designed to focus on the most important independent variables which account for the majority of the variance in the GDF emission source. The test design for controlled independent variables will take into account the measured correlations and their statistical significance in the uncontrolled tests. For example, the number of tested ambient temperatures can be reduced if the quadratic and higher order temperature effects are not significant (theoretically only two temperature values would be needed for the linear case), or by not testing all possible combinations of two independent variables if their interaction is not significant

The controlled series test design will specify the independent variables to be studied, the levels of each of these variables to be included, and the combinations of these levels across variables to be included. The design will be based on a correlation and regression analysis of the uncontrolled test series. The controlled series test design will likely be a factorial design, in which levels of independent variables are simultaneously varied.

The specific objectives of the controlled test series are therefore:

1. Quantify GDF emissions including transfer, vent line, spillage and fugitive sources for seven types of VRS: uncontrolled without vapor recovery, balance and vacuum assist (Tables 1-6 and 1-7) .

2. Refine the correlations between VRS type emission sources and the specific independent variables carried over from the uncontrolled test series that were demonstrated to influence GDF emission rate and magnitude.

3. Derive emission factors in pounds/1000 gallons dispensed for the seven VRS type emission sources, including transfer, vent line, spillage and fugitive sources.

4. Develop improvements to the existing C&TP and integrate these changes per CARB's request..

Based on these objectives, there will be a total of eight field test conditions for the controlled test series. The location of the GDFs will be in the east San Francisco Bay area.

Independent and Dependent Variables

Table 1-8 specifies the array of potential independent and dependent variables that will be measured or monitored in the field for each of the seven test conditions. The results of the uncontrolled test series will dictate which independent variables will be included in the controlled test series.

Table 1-6
Vapor Recovery System Test Conditions

Test Mode	VRS Type	Vent Valve	Assist Pump Location	Bell	Incinerator
1	None	No	N/A	No	No
2	Balance	No	N/A	No	No
3	Balance	Yes	N/A	No	No
4	Vacuum Assist	Yes	Dispenser	No	No
5	Vacuum Assist	Yes	Dispenser	Yes	No
6	Vacuum Assist	Yes	Roof	?	Perhaps
7	Vacuum Assist	Yes	Midstream	?	Perhaps

Table 1-7
Vapor Recovery Specifications

VRS Type	Manufacturer	Nozzle
Balance	(Executive Order 52)	Balance nozzles OPW III V or Husky V34* Emco Wheaton A4005 * - preferred
Balance ARCO	(Executive Order 52)	Balance nozzles OPW III V or Husky V34* Emco Wheaton A4005 * - preferred
Vacuum Assist Shell	Gilbarco VaporVac (Executive Order 150)	OPW II VAI
Vacuum Assist Chevron	Dresser Wayne (Executive Order 153)	OPW II VAI
Vacuum Assist Beacon	Hirt (Executive Order G-70-33) old system the new system is not certified	Balance nozzles OPW III V or Husky V34* Emco Wheaton A4005 * - preferred
Vacuum Assist UNOCAL/Tosco	Hasstech (Executive Order 7) (Executive Order 70-164) the new bootless system	Husky or OPW
Vacuum Assist ?	Healy (Executive Order 70) (Executive Order G-70-165) new system	Healy 200/400 (old) Healy 600 (new system)

Table 1-8
Possible Independent/Dependent Variables

Variable	Independent or Dependent	VRS System Type	Measurement Team
Ambient Temperature and Pressure	Independent	NBA	AVES
Site Location	Independent	NBA	AVES
Static Pressure	Independent	BA	BAAQMD
UST Temperature and Gauge Pressure	Independent	NBA	AVES
Vehicle Fuel Tank Temperature in Vapor	Independent	NBA	AVES
UST Ullage Capacity	Independent	NBA	AVES
Air/liquid Ratio	Independent	A	BAAQMD
Dynamic Back Pressure	Independent	B	BAAQMD
Station Design	Independent	NBA	AVES
Vent emissions	Dependent	NBA	AVES
Fugitive emissions	Dependent	NBA	AVES
Spillage emissions	Dependent	NBA	AVES
Bulk delivery emissions	Dependent	NBA	AVES

Where:

N = no control technology
B = Balance
A = Vacuum Assist
AVES = AeroVironment Environmental Services
BAAQMD = Bay Area Air Quality Management District

Field Tests

For each of the seven test conditions, the independent and dependent variable data will be collected with the same measurement or monitoring technologies that were used in the uncontrolled test series. Table 1-9 specifies the type of measurement methodology or equipment that will be used for data collection.

Table 1-9
Independent/Dependent Variables

Variable	Measurement Methodology
Ambient Temperature and Pressure	Meteorological Equipment
Site Location	Manual Recordkeeping
Static Pressure	ARB TP-201.3
UST Temperature and Gauge Pressure	Thermocouple and Pressure Transducer
Vehicle Fuel Tank Temperature in Vapor	Temperature Probe
UST Ullage Capacity	Tank Level Monitor
Air/liquid Ratio	ARB TP-201.5
Dynamic Back Pressure	ARB TP-201.4
Station Design	GDF Design Specs and Sales Data
Vent emissions	ARB TP-201.2
Fugitive emissions	ARB TP-201.2B
Spillage emissions	ARB TP-201.2C
Bulk delivery emissions	ARB TP-201.1

Where:

ARB TP-201.X = A ARB certification and test procedure

The static pressure, dynamic pressure, and air/liquid ratio tests will be executed prior to and after the collection of the other variable data to verify that the GDF VRS are operating properly. Before the field tests begin at a given GDF, the VRS manufacturer will be allowed to service the VRS to assure that it is in proper running condition before the collection of filed data commences.

SECTION 2

ORGANIZATION AND RESPONSIBILITY

The organization chart for this project is presented in Figure 2-1.

Dr. Robert Grant is the ARB contract officer for this project.

Dr. David Shearer will serve as AVES's project manager. He is responsible for the overall operation of AVES program. In addition, he is charged with crafting the study design and QAPP documents, overseeing the field study and drafting the project final reports.

A technical advisory panel (TAP) will provide technical review of project milestones. The TAP membership consists of the following individuals:

- Robert Grant, ARB
- James Loop, ARB
- Cynthia Castronova, ARB
- Laura McKinney, ARB
- Ken Kunaniec, CAPCOA
- Dave Good, USEPA
- Glen Passavant, USEPA
- Don Gilson, Western States Petroleum Association (WSPA)
- Harold Haskew, American Automobile Manufacturing Association (AAMA)

Mr. Stefan Unnasch from Acurex Environmental will be the manager of Acurex's work scope. He will be responsible for the set-up and operation of the monitoring sites. This includes the assembling of a field test van and executing the hydrocarbon, pressure, temperature, and flow measurement and data acquisition procedures as defined in the ARB C & TPs or the project proposal.

Mr. Chadd Garretson from Acurex Environmental, a senior measurement engineer, is the field site manager. He is charged with overall site operations responsibility relative to GDF interface, equipment set-up and tear down, and execution of the C & TPs.

Mr. Volker Druenert from Acurex Environmental, a senior instrument technician, is responsible for the calibration, maintenance and daily operation of the VRS and meteorological monitoring equipment.

Mr. Bernard Leong from Basic Research will assist the Acurex field staff in executing the field tests.

Mr. Ken Kunaniec from the Bay Area Air Quality Management District is responsible for the pre- and post-test VRS performance tests.

The performance and system audit responsibilities will be performed by Mr. David Bush, AeroVironment's manager for quality assurance.

Ms. Lydia Chu, head of the data management group, is responsible for the data reduction.

Project Organization

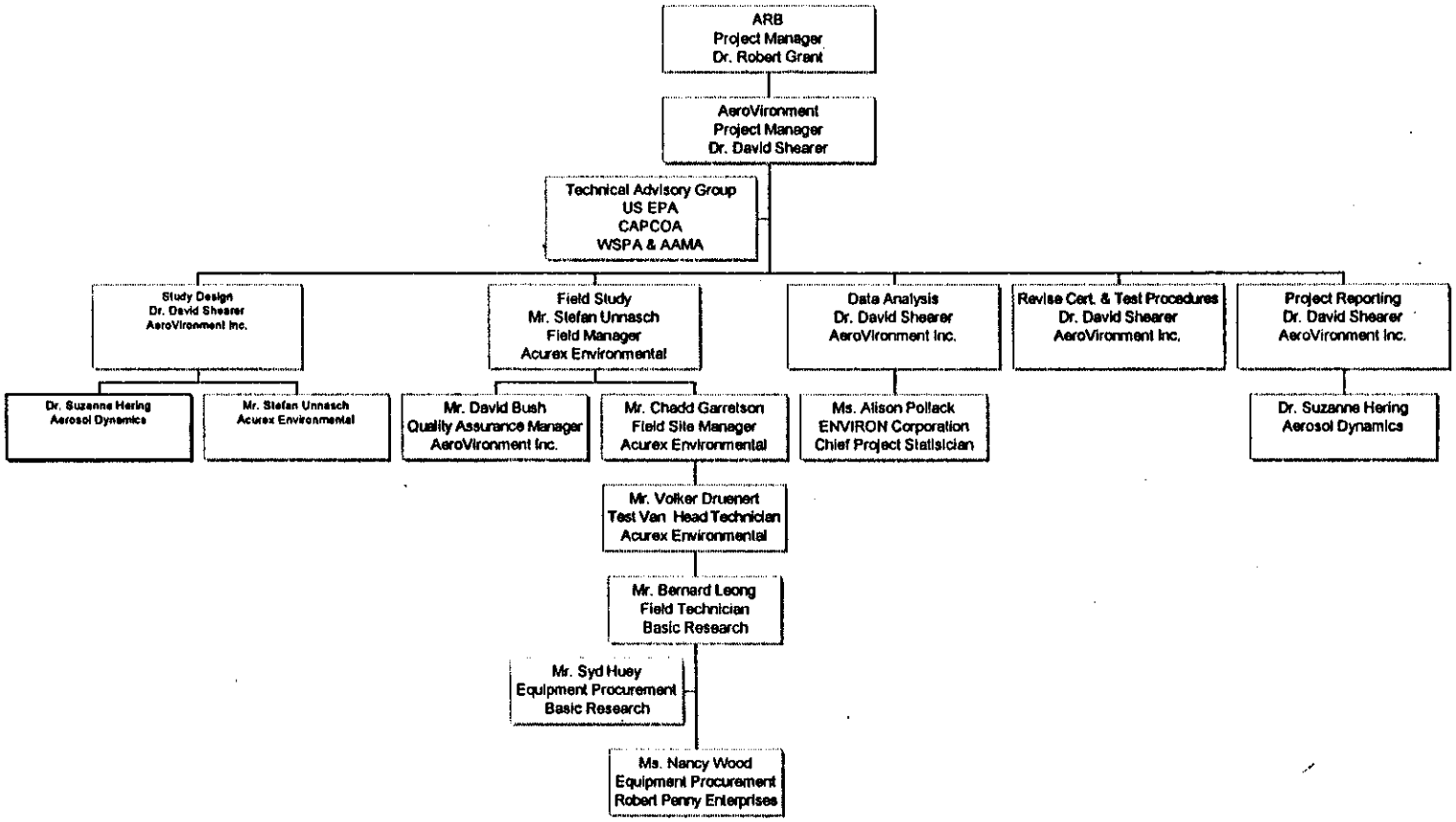


FIGURE 2-1.

Ms. Alison Pollack from ENVIRON is responsible for designing and executing the statistical analysis.

Dr. Suzanne Hering from Aerosol Dynamics is responsible for assisting in crafting the study design document.

Mr. Sidney Huey from Basic Research is responsible for purchasing the required field test equipment and data acquisition systems.

Mr. Robert Penny of Robert Penny Enterprise will assist in purchasing the required field test equipment and data acquisition systems.

SECTION 3

QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

3.1 INTRODUCTION

The Quality Assurance Project Plan defines the data quality goals for the project and the quality control activities necessary to obtain them. These goals are stated in terms of precision, accuracy and completeness. Quality Assurance (QA) is defined as independent assessments of the effectiveness of the measurement program and the quality assurance procedures employed. This includes both performance and system audits. Quality Control (QC) is defined as the operational procedures used to evaluate whether a measurement process is generating valid data. This includes periodic calibrations, duplicate checks, zero-span checks and review of the data for reasonableness and consistency. QC procedures are used to document claims of accuracy.

3.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Table 3-1 delineates the QA objectives for all field activities that generate data. These objectives are presented in terms of accuracy, precision and completeness. The Environmental Protection Agency (EPA) defines these terms as follows:

- Accuracy is the degree of agreement between the measurement or the average of measurements for a parameter and the accepted reference or true value. It is the combination of the bias and precision in a measurement system.

- Precision is the measure of mutual agreement among individual measurements of the same property.

- Completeness is the measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained.

Table 3-1
Quality Assurance Objectives
Field Measurement Program

Equipment	Accuracy	Precision	Data Completeness
Temperature			
Ambient Temperature K-type thermocouple	0.2 °F	0.2%.	85%
VRS Temperature K-type thermocouple	0.2 °F	0.2%.	85%
Pressure			
VRS Pressure Transducers* (Omega)	±0.50%	0.10%	85%
Ambient Pressure* Transducers (Sensyn)	±0.50%	0.10%	85%
Vapor Volume			
McMillian 100 Flo-Sen*	±3.0%	10%	85%
Roots Meters*	±3.0%	10%	85%
Hydrocarbon Measurement			
California Analytical NDIR*	10%	10%	85%
Beckman GC FID*	10%	10%	85%
Horiba GC-FID*	10%	10%	85%
Foxboro OVA*			85%
Ratfisch*	10%	10%	85%

SECTION 4

MONITORING PROCEDURES

AVES, in collaboration with Acurex Environmental Corporation, will execute the GDF measurement program. The measurement program is designed to conform to the requirements of the study design document and the ARB C&TPs. The C & TPs specify that hydrocarbon, pressure, temperature, and flow measurements will be executed at three locations on the site-specific Phase II vapor recovery systems:

- the nozzle/vehicle interface.
- the product dispenser return vapor line.
- the outlet for the underground storage tank vent line.

In addition, the C & TPs define protocols for assessing three other potential sources of GDF emissions:

- Phase I vapor recovery efficiency by measuring the volume of displaced gasoline vapor from the UST into the tanker truck.
- the estimated amount of fugitive emissions leaving site-specific vapor recovery systems as a function of facility pressure profiles.
- the amount of product spilled onto the GDF concrete pad as a function of the refueling events.

These measurements will be executed for both the uncontrolled and controlled test series. The uncontrolled test series will include three test sites and the controlled test series will include six test sites. The following discussion describes how the test sites were chosen and the how the parameter-specific measurements will be executed.

4.1 GASOLINE DISPENSING FACILITY SITE SELECTION PROTOCOL

The criteria for selecting the GDF measurement sites included the following characteristics:

- Proximity to both Sacramento and the San Francisco Bay area. The agreed upon locations are in the east San Francisco Bay Area within 75 miles of Sacramento.
- A product throughput of at least 100,000 gallons per month (> 16 nozzles).
- The presence of tank level monitors on the GDF underground storage tank or a computerized tracking system for product volume.
- The site has one of the seven system types required for the study.
- The sites are distributed evenly across the membership of the Western States Petroleum Association member companies.

Based on these criteria, Table 4-1 lists the sites that will be used for the field study. Within each site category, the primary site versus secondary sites is specified. This denotation clarifies which of the sites are backup locations (secondary) and which sites are the first choices within each vapor recovery category. At least two backup sites for each vapor recovery system type are identified.

Table 4-1
Field Test Locations

Vapor Recovery System Type	WSPA Member Company Site Number	Location	Primary/Secondary Location
Exempt	TBD	TBD	TBD
	TBD	TBD	TBD
Balance	ARCO #2180	3000 Travis Boulevard Fairfield, CA	Primary
	Chevron #5595	1700 Mt. Diablo Martinez, CA	Secondary
	Chevron #94640	2895 N. Main Street Walnut Creek, CA	Secondary
	Chevron #0336	4295 Clayton Road Concord, CA	Secondary
Gilbarco Vacuum Assist	Shell	3621 San Pablo Dam El Sobrante, CA	Primary
	Unocal 6013	119 Red Top Road Fairfield, CA	Secondary
	Shell Oil	3035 Geary Blvd. San Francisco, CA	Secondary
Dresser Wayne Vacuum Assist	Chevron 4014	2695 Pinole Valley Road Pinole, CA	Primary
	Shell	2690 Pinole Valley Road Pinole, CA	Secondary
	Chevron 3072	2329 N. Main Street Walnut Creek, CA	Secondary
	Shell	708 Admiral Callghgn Lane Walnut Creek, CA	Primary
Hirt Vacuum Assist	Rotten Robbie 36	1515 Danville Blvd. Alamo, CA 94507	Primary
	Beacon Oil 558	32245 Fremont Blvd. Fremont, CA	Secondary
	Olympic	2000 19th Avenue San Francisco, CA	Secondary
Hasstech Vacuum Assist	Unocal	10151 E. 14 Street Oakland, CA	Primary
	Beacon 594	40500 Fremont Blvd. Fremont, CA 94536	Secondary
	Olympic	3300 Army Street San Francisco, CA	Secondary
Healy Vacuum Assist	Chevron	4400 Piedmont Ave. Oakland, CA	Primary

4.2 METEOROLOGICAL MEASUREMENTS

At each site, ambient meteorological measurements will be data logged continuously during the C & TP measurement program. The location of the meteorological instrumentation will be in close proximity to the field test van to facilitate data logging ease. However, recognizing potential interferences from the field test van, the meteorological tower will be far enough away to minimize external interferences.

Ambient temperature values will be assessed using an Omega K-type thermocouple probe integrated with an Action Instruments TC temperature signal conditioner (Model 4351-2000). A K-type thermocouple functions by measuring the resistance across a thermocouple probe with a 0-5 volt scale. The temperature signal conditioner is a pulse accumulator which conditions the temperature resistance signal. A temperature value will be recorded every second and fed into the data acquisition system.

Ambient pressure will be recorded using a Sensyn Model LM1801 absolute pressure transducer. As with temperature, a pressure value will be determined every second and will subsequently be data logged..

4.3 HYDROCARBON MEASUREMENTS

The hydrocarbon measurements will be performed according to the procedures specified in ARB C & TPs. For this project, there are five relevant certification and test procedures:

TP-201.1 - Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors: During bulk gasoline delivery, the volume of gasoline delivered for the cargo tank to the GDF storage tank is recorded. The volume of gasoline vapor discharged from the vent pipe of the storage tank is measured. From these parameters, the Phase I volumetric efficiency is determined.

TP-201.2 - Determination of Efficiency of Phase II Vapor Recovery Systems of Dispensing Facilities: The purpose of this test procedure is to determine the percent vapor recovery efficiency for a vapor recovery system at a GDF. The percent vapor recovery efficiency is the percent of vapors displaced by dispensing which are recovered by a vapor recovery system rather that emitted to the atmosphere.

TP-201.2A - Determination of Vehicle Matrix for Phase II Vapor Recovery Systems of Dispensing Facilities: The sample of vehicles to be used in Method TP-201.2 for testing vapor control systems shall be made up of vehicles representative of the on road vehicle population in terms of vehicle miles traveled. This calculation procedure produces such a representative vehicle matrix.

TP-201.2B - Determination of Flow Versus Pressure for Equipment in Phase II Vapor Recovery Systems of Dispensing Facilities: The purpose of this test procedure is to determine The fugitive emissions and the vapor recovery efficiency at GDFs. The mass flux of fugitive emissions from a dispensing facility is the product of the volumetric flow rate and the flow-weighted mass per volume concentrations. The volumetric flow rate is based on data for pressure vs. time from the facility and data for flow vs. pressure from a model of the facility. The model flow vs. pressure data are to provide a conversion for the facility pressure vs. time data to flow vs. time data.

TP-201.2C - Determination of Spillage of Phase II Vapor Recovery Systems of Dispensing Facilities: After the vapor recovery nozzles are inspected and determined to be in good working order (as specified in CCR 94006), a presurvey calibration of pours is performed. This calibration will determine the areas of 1 mL, 5 mL, and 25 mL pours at the location of the test. When the calibration is completed, vehicle fuelings are observed and measurements are made to quantify any observed spills.

The specifics of these test procedures are contained in Appendices A-E. Unless specified in this document, the hydrocarbon test procedures will be executed as specified in the C & TP. TP-201.1, TP-201.2, TP-201.2A and TP-201.2C will be are executed in the field. TP-201.2B will be executed in the Acurex laboratory as a benchtop experiment with site-specific pressure signatures provided by the BAAQMD performance tests.

For the purposes of this project and as specified in TP-201.2, there will be three test locations at each of the field test sites where hydrocarbons (temperature, pressure and vapor volume will also be measured at these test points) will be quantitatively measured (Figure 4-1 [Appendix B, Figure 1, TP-201.2}):

- Test Point 1 - The nozzle fill neck interface
- Test Point 2 - The dispenser vapor return line
- Test Point 3 -The UST vent line outlet

In addition, an ancillary hydrocarbon detection procedure (measured as percent LEL) will be executed at only test point one for the purposes of assessing leakage at the vehicle/nozzle interface.

4.3.1 Analytical Procedures for TP-201.2

As specified in the C & TPs, the hydrocarbon measurements will be performed according to EPA reference method 25A and 25B. EPA Method 25A describes the determination of total gaseous organic compound emissions using a flame ionization detector and EPA Method 25B specifies the determination of total gaseous organic compound emissions using a nondispersive infrared analyzer.

The principle of operation for the flame ionization detector method (EPA 25A) is that a hydrocarbon gas sample is extracted from the source through a sample line and a glass fiber filter to a flame ionization analyzer. Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents. The principle of operation for the nondispersive infrared method (EPA 25B) is similar. A hydrocarbon gas sample is extracted from the source through a sample line and a glass fiber filter to a nondispersive infrared analyzer (NDIR). analyzer. Results are also reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

The specifications of the hydrocarbon analyzers to be used for this project are tabulated in Table 4-2. Based the specifications defined in TP-201.2, the primary distinction between the sample trains for the FID and NDIR analyzers is that the hydrocarbon sample stream from the NDIR is returned unaltered from the NDIR outlet to the sample manifold. The hydrocarbon sample train for each sample points is described in Appendix B for sample points 1-3. The exception to this reference is for sample point 3. A method developed by AeroVironment for a UST vent line study (AeroVironment, 1994) will be used. Figure 4-1 illustrates the sample train to be used for this method.

Table 4-2
Hydrocarbon Analyzer Specifications

Instrument Model Number	Analytical Method	Test Points	Operating Range (ppm as C_3)	Use
Horiba Model OPE-435	FID	3	0-1000	Low sleeve Test Point Used to Assess End of Event
Ratfisch Model RS 55CA	FID	3	0-1000	Vent Line High Flow (100-150 lpm)
Beckman Model 400A	FID	1	100,000 (0-10%)	High Concentration at Nozzle/fillneck Interface
Century OVA Model 128GC	FID	3	0-100	Vent Low Flow Qualitative Measure to Assess Breakthrough at P/V Valve
California Analytical Model 100	NDIR	2	1,000,000 (0-100%)	Return Line

An additional hydrocarbon detection procedure will be executed only at test point one. The purpose of this procedure is to check for hydrocarbon leaks at the nozzle vehicle fillneck interface. Leaks in excess of 0.1% of LEL will be deemed as not conforming to the maximum leakage requirements for a vehicle to qualify for additional hydrocarbon testing. The methodology to execute this procedure is specified in TP-201.2, Sections 5.1 8.1.1.4.2 (Appendix B). The hydrocarbon leak detection will be executed with a combustible gas detector (Century OVA Model 108), as specified in EPA Method 21.

The duration of the hydrocarbon assessment procedures for each vapor recovery system type will be 2-3 days. The extent of testing will be determined by the time it makes to measure hydrocarbon emissions for 100 vehicle refueling events. The specific vehicles to be tested are notated in the 100 car matrix published by ARB. The 100 car matrix is intended to represent the current fleet mix found on California's roadways based on vehicle miles traveled. The refueling events must be for at least X gallons.

The hydrocarbon data will be data logged into the data acquisition system with a data point collected every second from each of the hydrocarbon analyzers.

4.3.2 Analytical Procedures for TP-201.2B

The procedures for TP-201.2B are contained in Appendix D. The objective this C & TP is to estimate site-specific fugitive emissions by determining the flow leaving the facility as a function of VRS pressure signatures. Fugitive emission sources include UST vent lines equipped with P/V valves, "closed" idle nozzle check valves and "closed" overfill drain valves.

Several parameters need to be quantitatively measured to produce a value for fugitive mass flux including:

- Facility VRS volumetric leak flow rate
- Facility VRS pressure profiles
- Hydrocarbon concentrations (hydrocarbon mass/volume of hydrocarbon emitted
- Facility VRS temperate profiles

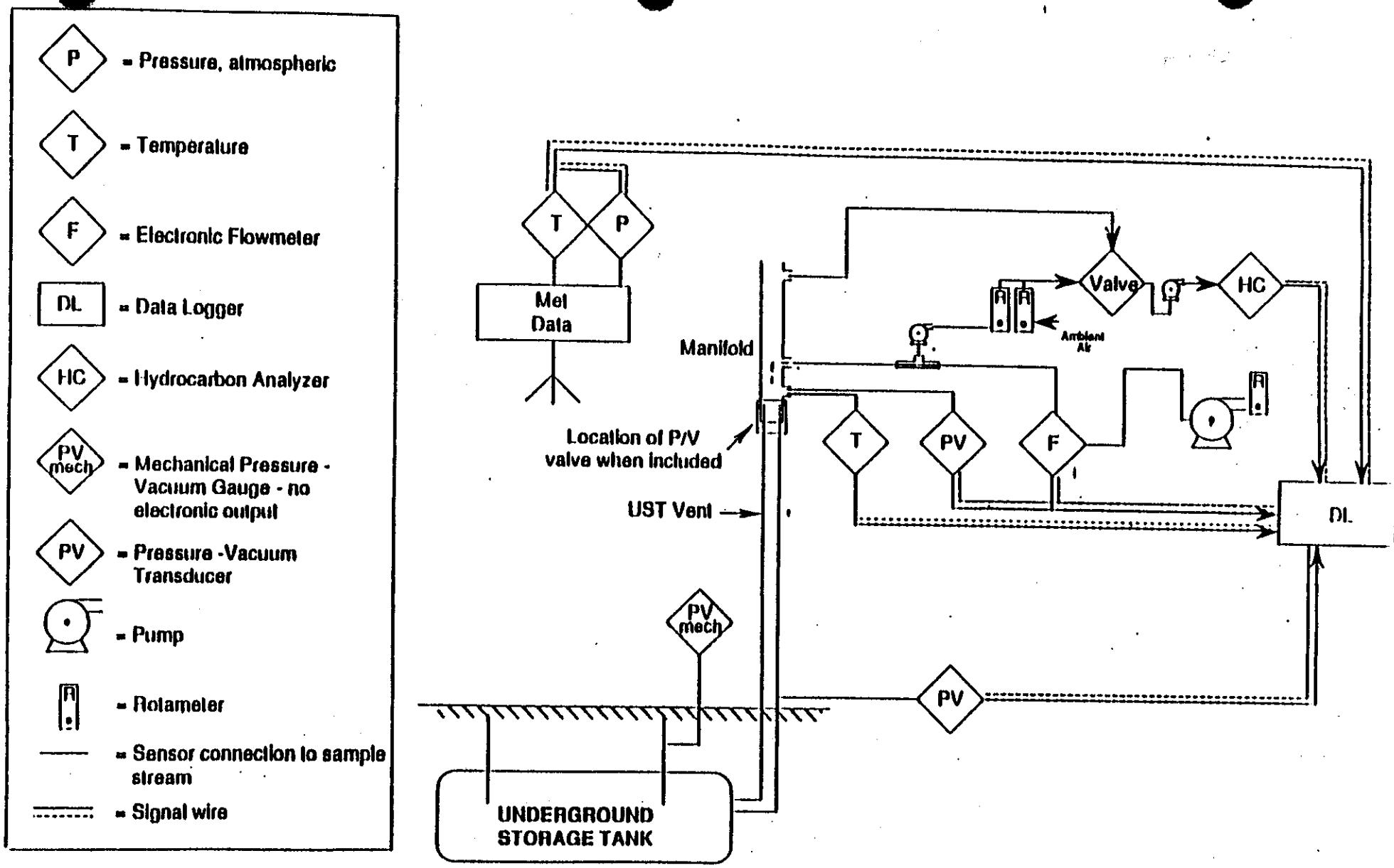


FIGURE 4-1. Underground Storage Tank Vent Line Monitoring Scheme.

To generate the pressure and flow values, the Bay Air Quality Management District will execute two inch static pressure performance tests (C & TP TP-201.3) at each field test sites. This procedure pressurizes the entire vapor recovery system to two inches water column. After five minutes, the VRS pressure is noted and compared to allowable levels. Using standard engineering principles, the volumetric leak flow rate can be calculated. This value, coupled with the flow-weighted hydrocarbon mass per volume concentration yields the mass flux of fugitive emissions leaving the GDF for the TP-201.3 pressure conditions.

Hydrocarbon concentrations (mass/volume) will be assayed at the field test sites at test point 3 with P/V valves in place. Facility pressure and temperature profiles will be collected during the execution of TP-201.2 at test points 1-3 for representative facility operating conditions. These include maximum and minimum facility throughputs and product bulk drops.

To model the facility, a piece of capped PVC pipe will be pressurized using bottle nitrogen. A small hole will subsequently be added to the PVC pipe such that the flow out that hole equals the site-specific leak flow rate as a function of pressure (as determined by TP-201.3). Having established the facility model, volumetric leak flow rates will be determined for the time dependent pressure profile conditions found at each field test sites. These data will then be coupled with the hydrocarbon mass/volume data to produce an estimate of field test site-specific hydrocarbon fugitive emissions.

4.3.3 Analytical Procedures for TP-201.2C

The procedures for TP-201.2C are contained in Appendix E. TP-201.C is not predicated on an analytical procedure but is dependent on observations based on a standardized frame of reference. At each field test site, discrete increments (1 mL, 5 mL and 25 mL) of gasoline will be poured onto the GDF surface in an area that is similar to the pavement where the majority of refueling spills occur. The diameter of the spill surface will be measured. Having calibrated the area for each spill category, the number of spills per refueling episode will be visually cataloged. The refueling event will be disaggregated into three segments: removal of the nozzle from the pump, dispensing of liquids into the vehicle and removal of nozzle from the vehicle and returning it to the dispenser. The number refueling events to be observed is subject to negotiation with the ARB staff. Using the standardized reporting forms found TP-201.2C, the spillage data collected from the refueling events will be converted into pounds of gasoline spilled and spatback per 1000 gallons of gasoline dispensed.

4.3.4 Analytical Procedures for TP-201.1

The combustible gas meter will be used in TP-201.1 to quantify any hydrocarbon vapor leaks occurring during a gasoline product bulk drop. The measurement location is test point 5. TP-201.1 defines three test points which are illustrated in Appendix A, Figure 1(page 13):

- Test Point 5 - The UST product drop tube (Test point 1 in Figure 1, TP-201.1)
- Test Point 6 - The tanker vapor return line (Test point 2 in Figure 1, TP-201.1)
- Test Point 7 - The UST vent line outlet (Test point 3 in Figure 1, TP-201.1)

The data from test point five will not be data logged but will be cataloged on the forms found in Appendix A.

4.4 PRESSURE MEASUREMENT

Based the specifications of TP-201.2, pressure readings will be taken at test points 1-3 concurrent with the hydrocarbon measurements. Pressure will be assessed at all of field test sites for both the uncontrolled and controlled test sites. The specific locations of the pressure transducers on the sample manifold relative to the flow measurement devices (roots meter or flow meter) are noted in TP-201.2 (Appendix B). In general, they are upstream from the hydrocarbon vapor flow devices. The pressure transducers that will be used are tabulated in Table 4-3.

Table 4-3
Pressure Transducers

Transducer Make	Model	Range
Omega	PX-653-0.025BD5V	± 0.25 in. WC
Omega	PX654-01BD5V	± 1.0 in. WC
Omega	PX240	±0 2.5 in. WC
Omega	PX654-50BD5V	±0 5.0 in. WC
Omega	PX654-10BD5V	±0 10.0 in. WC

4.4.1 Analytical Procedures for TP-201.2

As is apparent from Table 4-3, a range of differential Omega pressure transducers will be available for the field technicians. The specific transducer that will be used will depend on the vapor recovery system pressure profile at the time of the test. For each of the three test point locations, the pressure values will be recorded every second and data logged using the test van data acquisition system.

In addition to the three test point pressure transducers, at the vent and nozzle locations, a magnehelic gauge (0-25 in WC) will also be used to assess vapor recovery system pressure. This is feasible because the test system is steady state. The pressure at each of these locations will be recorded on field data sheets for each refueling episode.

4.4.2 Analytical Procedures for TP-201.1

TP-201.1 specifies that pressure and temperature will be quantitatively measured at the outlet of the UST vent line (test point 7) during a product drop while concurrently measuring the volume of gasoline vapor exiting the vent line. The appropriate range pressure transducer will be used for this purpose and the output signal will be data logged using the field test van data acquisition system. One value per second will be recorded. The pressure transducer will be mounted onto the sample manifold upstream from the vapor volume measurement device.

4.4.3 Analytical Procedures for UST Pressure

As specified in the project study design document, UST pressure will be monitored continuously at each of the field test locations during the execution of the C & TP for the uncontrolled test series. In addition, based on published and unpublished GDF data, it is anticipated that UST pressure will also be assayed during the controlled test series for each of the field test sites. The methodology for executing this study requirement will depend on whether the UST (for the

product dispenser to be tested) has a vacant coupling that can be fitted with the appropriate range Omega differential pressure transducer. If a UST coupling is accessible and available, the pressure transducer will be fitted to the UST and the data will be continuous recorded with the test van data acquisition system. If a coupling is neither accessible or available, a pressure transducer with the appropriate range will be fed down the UST vent line until it hits grade. The pressure profile at this location will serve as a surrogate for the UST pressure during the execution of the C & TPs. This data stream will be continuously recorded with a pressure data point data logged every second for the duration of the hydrocarbon measurement program.

4.5 TEMPERATURE MEASUREMENT

Based on the specifications of the study design document and the relevant C & TPs, at each of the test site locations in the uncontrolled test series hydrocarbon vapor temperature will be continuously recorded at test points 1-3 and in the UST for the product dispenser being evaluated. Hydrocarbon vapor temperature values will also be assayed for test points 1-3 in the controlled test series depending on the outcome of the uncontrolled test series data analyses.

4.5.1 Analytical Procedures for TP-201.2

Temperature will be measured using Omega K-type probe integrated with an Action Instruments TC temperature signal conditioner (Model 4351-2000). A K-type thermocouple probe functions by measuring the resistance across a thermocouple with a 0-5 volt scale. The temperature signal conditioner is used to convert the thermocouple probe analog output into a digital signal that can be input into the field test van data acquisition system. The range of the K-type thermocouple probe is 0-200 °F. The specific locations of the thermocouples probe on the sample manifold relative to the flow measurement devices (ROOTS® meter or flow sensors) are noted in TP-201.2 (Appendix B). In general, they are upstream from the hydrocarbon vapor flow devices. A temperature value will be recorded every second and fed into the data acquisition system.

4.5.2 Analytical Procedures for TP-201.1

TP-201.1 specifies that temperature be quantitatively measured at the outlet of the UST vent line (test point 7) during a product drop while concurrently measuring the volume of gasoline vapor exiting the vent line. A K-type thermocouple probe linked with a Action Instruments TC temperature signal conditioner (Model 4351-2000) will be used for this purpose and the output signal will be data logged using the field test van data acquisition system. One value per second will be recorded. The K-type thermocouple probe will be mounted onto the sample manifold upstream from the vapor volume measurement device.

4.5.3 Analytical Procedures for UST Temperature

As specified in the project study design document, for the uncontrolled test series UST temperature will be monitored continuously at each of the field test locations during the execution of the C & TP. In addition, depending on the results of the statistical analyses, UST temperature will also be assayed during the controlled test series for each of the field test sites. The methodology for executing this study requirement will depend on whether the UST (for the product dispenser to be tested) has a vacant coupling that can be fitted with a K-type thermocouple probe. If a UST coupling is accessible and available, the K-type thermocouple probe will be fitted to the UST and the data will be continuous recorded with the test van data

acquisition system. If a coupling is neither accessible or available, a thermocouple probe with the appropriate range will be fed down the UST vent line until it hits grade. The temperature profile at this location will serve as a surrogate for the UST temperature during the execution of the C & TPs. This data stream will be continuously recorded with a temperature data point data logged every second for the duration of the hydrocarbon measurement program.

4.5.4 Analytical Procedures for Vehicle Tank Temperature

As specified in the project study design document, for the uncontrolled test series vehicle tank vapor temperature will be monitored for each refueling event at each of the field test locations during the execution of the C & TP. In addition, it is possible that vehicle tank vapor temperature will also be assayed during the controlled test series for each of the field test sites. The methodology for executing this study requirement will consist of K-type thermocouple probe with a Tygon® sheathed intrinsically safe lead that can be fed into the vehicle fillneck assembly. The K-type thermocouple probe will be attached to a thermocouple indicator. This data stream will be manually recorded on a clip board and eventually entered into the data acquisition system.

4.6 VOLUME MEASUREMENT

Pursuant to the C & TPs specifications, the volume of hydrocarbon vapor will be measured at test points 1-3 for both the uncontrolled and controlled test series. While TP-201.2 (Appendix B) specifies the use of rotary positive displacement gas volume meters (e.g., ROOTS® meters) for this task, previous research has demonstrated that these devices may impede the flow of hydrocarbon vapors thus underreporting hydrocarbon vapor volume after correcting for temperature and pressure. An alternative method to quantify hydrocarbon vapor volume was developed and validated by AeroVironment Inc. (1994) using turbine flow sensors. Based on the proposed and accepted methodology for this project, this method will be used at test points 1 and 3 to assay hydrocarbon vapor.

4.6.1 Analytical Procedures for TP-201.2

MacMillian 100 Flo-Sen turbine flow sensors will be used to measure hydrocarbon vapor volume at the nozzle/fillneck interface and at the outlet of the UST vent line (test points 1 and 3). The range of the flow sensors is 0-100 liters per minute. The principle of operation for the flow sensors is that a Pelton type turbine wheel is used to determine the flow rate of the hydrocarbon vapor. As the turbine wheel rotes in response to gas flow rate, electric pulses are generated. Processing circuitry provides a D.C. voltage output (0-5 V) that is proportional to flow rate. This voltage output signal will be data logged each second and stored in the field test van data acquisition system. For these test points, vapor recovery system pressure and temperature will be measured at the inlet of the flow sensor. The hydrocarbon sample will be collected at the outlet of the flow sensors.

At test point 2, a ROOTS® rotary positive displacement gas meter will be used to quantify hydrocarbon vapor volume. The ROOTS® meter that will be used is a Dressor Model 3M175. The ROOTS® meters volume measurements will be electronically logged using a solid state pulser that transmits 100 pulses per revolution (where one revolution equals 1 cubic feet). Pulses will be totaled using an Action Instruments pulse accumulator which provides an operating range of 0-4180 pulses full scale. These values will be data logged using the field test van data acquisition system. During data processing, the hydrocarbon vapor volumes will

be corrected for temperature and pressure based on the ambient temperature and pressure data collected concurrent with the C &TP test series.

4.6.2 Analytical Procedures for TP-201.1

In addition to assaying hydrocarbon vapor volume for Phase II vapor recovery systems, for the purposes of this project and as specified in TP-201.1 (Phase I Vapor Recovery System Efficiency), there will be one test location (test point 7) at each of the field test sites where hydrocarbon vapor volume will be measured. At test point 7, a ROOTS® rotary positive displacement gas meter(Dressor 3M 175) will be used to measure the volume of gasoline vapor discharged from the outlet of the UST vent line. A data point for vapor volume will be generated per second and data logged using the same pulse accumulator previously described.

4.7 OTHER INDEPENDENT VARIABLES

In addition to the aforementioned parameters, the uncontrolled test series study design specifies the collection of data for a range of independent variables at each of the field test sites. These parameters will be statistically related to the dependent measures (i.e., hydrocarbon emissions) in the data analysis portion of this study. The independent measures of interest are listed in Table 4-4:

Table 4-4
Additional Independent Variables for the Uncontrolled Test Series

Variable	Measurement Methodology
Site Location	Manual Recordkeeping
Vehicle Fuel Tank Temperature in Vapor	Temperature Probe
UST Ullage Capacity	Tank Level Monitor
Product Throughput	Tank Level Monitor or Sales Records
Station Design	GDF Design Specs and Sales Data

The methodology to collect data for these parameters is specified in Table 4-4. Data on site location, UST ullage capacity, product throughput and station design will be collected based on engineering drawings and sales records. The methodology to collect vehicle fuel tank vapor temperature is described in section 4.5.4.

Inclusion of these independent measures into the controlled test series will depend on whether they are significantly related to the dependent measures in the uncontrolled test series data analysis.

4.8 DATA ACQUISITION SYSTEMS

All of the collected independent and dependent measure parameters will be data logged at one second intervals using a personal computer (PC) based data acquisition system. The PC is equipped with a 75 megahertz Pentium CPU processor and a standard I/O board (Model C10-DAS1-602/16 made by Computer Board) with 16 single ended channels The data logging computer software is Laboratory Notebook. In addition to PC base data acquisition, strip chart records will also be used to record the continuous independent and dependent variables.

4.9 PRE-TEST AND POST-TEST MEASUREMENTS (STATIC AND DYNAMIC PRESSURE AND A/L TESTS)

As specified in the both the uncontrolled and controlled test series study design, prior to and following the execution of C &TPs, the site-specific vapor recovery systems will be evaluated for ARB specified performance. These tests will determine if the VRS are functioning according to manufacturers design and ARB mandated performance specifications. Three performance tests will be executed by Bay Area Air Quality Management District (BAAQMD) staff who are specially trained to execute these tests. The tests and their respective ARB designations are listed in Table 4-5.

Table 4-5
ARB Performance Tests

Variable	Measurement Methodology
Static Pressure	ARB TP-201.3
Dynamic Back Pressure	ARB TP-201.4
Air/liquid Ratio	ARB TP-201.5

If the particular VRS that is being tested does not pass the performance tests before the hydrocarbon emission testing is initiated, the VRS will be serviced and retested to assure that its passes the minimum specifications for vapor recovery system performance.

The performance data for each of the performance tests will be logged onto ARB sanctioned data sheets and will later be included in the project final report. In addition, the site-specific pressure profiles will be used as input data to execute TP-201.2B, the fugitive emissions C &TP.

4.9.1 Analytical Procedures

The analytical procedures for each of the performance tests are found in the ARB C & TPs.

4.10 SITE OPERATING PROCEDURES, QUALITY CONTROL CHECKS AND CALIBRATION

Field test site checks will be performed daily by the field test staff to ensure that the test equipment is properly installed and functioning correctly and that the field test van functioning according to design. Acurex field staff will be trained for these procedures. Hydrocarbon analyzer zero-span checks will be performed daily. Calibration of the hydrocarbon analyzers will be performed at the beginning and end of each site-specific field program. Additional calibrations will be performed quarterly or when analyzers are repaired and reinstalled.

The meteorological sensors will be calibrated at the beginning of the field measurement program.

4.10.1 Van Check Procedures

Field test van checks will be performed during each site visit by the site technician following a format prescribed by the field test station check forms. A model form for a ozone analyzer is illustrated in Figure 4-2. A form will be designed that is specific to the field test van.

KCRA Tower Check List Log

Instrument	Item Checked	Reference	Range	Before	After
Station	Date	mm-dd-yy	NA		
	Time	hh:mm	NA		
	Checked by	Name	NA		
Chart Recorder	Trace	clear	NA		
	Supply	> 4 feet	NA		
	Date/Time	Mark chart	NA		
Data Logger	Proper time	PDT	+/- 2 min		
Ozone Daisbi 1008RS Analyzer	Sample flow	1.9 lpm	1.5 to 2.0		
	Sample frequency	40 K	30 to 48		
	Control frequency	50 K	50		
	Cell temperature	39 deg C	35 to 45		
	Sample pressure	atm	>0.8		
	30 ft				
	400 ft				
	800 ft				
	1200 ft				
	1600 ft				
	Auto span	Record setting			
	Last A factor	NA	NA		
	Last B factor	NA	NA		
Zero check	Lamp setting	off	NA		
	Trn-std display	0.010 ppm	.005 to .015		
	DAS	0.000	-.005 to .005		
Precision check	Lamp setting				
	Trn-std display	0.100 ppm	.090 to .110		
	Trn-std true	0.090 ppm	.081 to .099		
	DAS	0.090 ppm	.081 to .099		
	% difference	0%	+/- 10%		
Span check	Lamp setting				
	Trn-std display	0.410 ppm	.369 to .451		
	Trn-std true	0.400 ppm	.360 to .440		
	DAS	0.400 ppm	.360 to .440		
	% difference	0%	+/- 10%		
Dasibi 1003 Transfer Standard	Sample flow	1.9 lpm	1.5 to 2.0		
	Sample frequency	40 K	30 to 48		
	Control frequency	50 K	24 to 30		
	Cell temperature	39 deg C	35 to 45		
	Auto span	Record setting			
	Last A factor	NA	NA		
	Last B factor	NA	NA		
	Site pressure	29.9 in. Hg	NA		

Transfer standard true =
(("trn-std" - "trn-std zero")*(29.9/"site press")*(273+"cell temp"/313)^"last A")-"last B"

The purpose of the field test van check is to ensure that the monitoring van is operating properly. This procedure gives warning of developing equipment problems and identifies instrument problems.

During each field test van check, the site technician visually inspects the meteorological sensors, the temperature, pressure, and flow probes, hydrocarbon inlet system (i.e., the sample manifold) and the hydrocarbon analytical equipment.

The field test van has a bound logbook for notating Acurex's comments concerning the test van operation as well as maintaining a record of van maintenance activity. AVES's and Acurex's procedures require that a logbook entry be made whenever a test van is serviced, checked or altered. It serves as a legal record of all activities within the field test van and is used to substantiate the integrity of the collected data.

Once a month, the field site technicians will send copies of all recorded data and logbook pages to AVES San Francisco for processing.

4.10.2 Quality Control Checks and Frequency

The quality control checks include periodic operational checks of the field instruments by the site operator coupled with computerized data screening by AVES Monrovia data processing operations for outliers.

4.10.2.1 Zero, Span and Precision Checks - Hydrocarbons

Each of the hydrocarbon analyzers will be subjected to a zero and span check on a daily basis (drift check every 2-3 hours). The zero and span check data will be reviewed daily by an Acurex data technician.

As specified in EPA Methods 25A and 25B, the FID and NDIR analyzers will be calibrated using primary gas standards of appropriate concentrations. Standards in excess of 9,000 ppm will be blended on-site using an Environs mass flow gas dilution system (Series 4000) plus research grade propane (C_3). Other sources of liquid propane may be used if they can be shown to be equivalent to research grade with reference to instrument response equivalency (i.e., within 2% of range for mid-level gas). The span gas concentrations are about 90 percent of the analyzer's nominal operating range. The measurement system performance specifications will be ± 3 percent of the span value for zero drift, and calibration drift and ± 5 percent for calibration error.. The frequency of calibration will be daily: prior to testing, two hours after the initial calibration was executed and at any time a calibration drift is evident. The OVA will be calibrated with a high range and 0 gas.

To perform zero and span checks, a zero concentration and one span concentration is introduced into each analyzer. The span gas concentrations are about 90 percent of the analyzer's nominal operating range. The analyzer operates in its normal sampling mode. The test gas passes through all filters, scrubbers, conditioners and other components used during normal sampling.

The zero and span data are used to determine whether the analyzer is in need of adjustment and to evaluate the validity of the data obtained. The following criteria are used in evaluating the data:

Zero checks-As part of the quality control checks, the daily zero checks should be within ±3% of full scale from the zero value established during the calibration. If on two consecutive zero checks (at least one day apart) the zero is greater than this tolerance the instrument will be removed from service, the problem corrected, the instrument calibrated and put back on line. If the zero check exceeds 4% of full scale the instrument will be taken off line immediately, a "before" calibration performed, the problem with the instrument corrected and a new "after" calibration performed. If the zero check exceeds 5% of full scale, serious instrument problems are present with the monitor and/or calibration system. This is a threshold to invalidate data. The same action as the 4% criteria should be taken.

Span checks-As part of the quality control checks, the daily, or other interval, span checks (1.5 -2.5 times of the expected concentration) should be within ± 10% of span value established during the calibration. If on two consecutive span checks (at least one day apart) the span is greater than this tolerance the instrument will be removed from service, the problem corrected, the instrument calibrated and put back on line. If the span check exceeds 15% the instrument will be taken off line immediately, a "before" calibration performed, the problem with the instrument corrected and a new "after" calibration performed. If the span check exceeds 25%, serious instrument problems are present with the monitor and/or calibration system. This is a threshold to invalidate data. The same action as the 15% criteria should be taken.

Precision checks will performed each month using a span gas 20% of the hydrocarbon analyzer range. At least four different measurements will be taken. The mean and standard deviation of these values will be used to calculate the precision value.

4.10.2.2 Temperature

Temperature quality assurance checks will be executed on a monthly basis using a one point intercomparison between a field standard (an Campbell 107 naturally aspirated thermometer) and the K-type thermocouple probe.

4.10.2.3 Pressure

Ambient pressure quality assurance checks will be executed on a monthly basis using a one point intercomparison between a field standard (a portable altimeter) and the pressure transducer.

For each of the vapor recovery system pressure transducers that will be used in this study, a calibration check will be executed prior to and immediately following the test period in accordance to manufacturers specification.

4.10.2.4 Volume

The flow sensors will be calibrated with the ROOTS® meter in the field test van and checked for proper running order at the onset, during the middle and at the conclusion of the testing for each field test location., The ROOTS® meters used for this project will be calibrated on an annual basis.

4.10.3 Calibration Procedures and Frequency

Calibrations establish data accuracy and data comparability by ensuring traceability of the transfer standards to higher quality standards such as the EPA reference calibration methods

and NIST standards. They also verify instrument operation and response. The requirements for calibration of air quality instruments and meteorological equipment have been specified by the EPA (Quality Assurance Handbook for Air Pollution Measurement Systems, Vols. II and IV. EPA-600/4-77-027a, 1987, 1989). For some instruments, calibration standards have not been established and these are calibrated in accordance with AVES's experience.

The standard used to obtain test concentrations for hydrocarbons is specified in the Traceability Protocol for Establishing True Concentration of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol No. 1) (June, 1978) published by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park. Working standards documentation is maintained in a central file at Acurex.

4.10.3.1 Hydrocarbon Calibration Equipment and Procedure

Once a week, the hydrocarbon instrumentation will be calibrated before the daily zero and span checks with three gas concentrations: low-level (25-35% of applicable span value), mid-level (45-55% of applicable span value) : high-level (80-90% of applicable span value). The field technician will also recalibrate an analyzer whenever the zero, or span checks indicate that recalibration is necessary or whenever an instrument has been repaired or serviced. For meteorological instrumentation this interval is once every six months.

4.11 PREVENTATIVE MAINTENANCE

All aspects of maintenance are prescribed and performed according to manufacturer's specifications, which provides for regular, thorough maintenance of each instrument owned or operated by AVES or Acurex. Full-scale maintenance of each instrument is performed at regularly scheduled intervals at AVES's or Acurex's instrument shop in Monrovia. In addition, the site technician follows established procedures for regular maintenance, while the instrument is in the field.

All instruments were serviced prior to field deployment. Except for sample inlet filter changing, no routine instrument maintenance is required during the monitoring project.

4.11.1 Spare Parts Policy

AeroVironment and Acurex maintains a complete inventory of spare parts and equipment for this program at its Monrovia and Mountain View facilities. AVES's and Acurex's parts inventory is based on both manufacturers' recommendations and its own experience with equipment problems from both normal operation and vandalism-induced failure.

4.11.2 Training

The site technicians will be trained by Acurex in the following areas:

- Site and field test van check procedure and operation
- Equipment maintenance
- Record keeping

This training takes place partially through updates and changes to the standard operating procedures. Constant communication among the site technician and the Field Operations Manager is also invaluable to the training process.

SECTION 5

DATA REDUCTION, VALIDATION AND REPORTING

The objective of the data processing and validation effort is a quality assured data base containing the project monitoring data in a consistent format. The procedures that AVES has implemented for data processing and validation ensure that reported data are valid and comparable to those collected by federal, state and local air pollution agencies. These procedures meet the requirements and guidelines of the Environmental Protection Agency, e.g., Appendices A and B of 40 CFR 58; Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I and II (1984, 1987b). Data processing procedures for this program are discussed below.

5.1 DATA BASE and PROCESSING

At the beginning of the project, before data are forwarded from the field, AVES's database coordinator, with the aid of the section manager, will create a project database directory. This directory will contain information specific to the project. A directory entry will be made for each of the parameter months of data on the database. The following information will be entered into the project-specific directory:

- project name
- site number(s)
- site name(s)
- component number (e.g., O_3=44201)
- reporting period
- status code
- units (ppm)
- reporting precision (specifies number of decimal places)
- outlier flags
- date of last access and update

In the field, data will be collected using data loggers with a capacity to store about two weeks of data. AVES San Francisco will retrieve the data every two weeks from the Acurex field staff. The polled data will be automatically screened for anomalies. Any anomalies will cause AVES's computer to alert data processing personnel to investigate.

Most data processing activities, including data screening and filtering, universal data editing and handling, data file indexing and protection will be conducted with the aid of AVESEDMS. The AVESEDMS database system has been tested and documented completely. AVES's data-processing staff includes a database coordinator dedicated to testing, maintaining, documenting, and controlling AVESEDMS. The following list summarizes some of the data processing and validation procedures that are handled automatically by application software and command language procedures.

- Outlier screening of data summaries
- Database loading of data
- Updating of on-line status files
- Database entry and editing
- Database access and process flow control

- Data flagging
- Data calibration (if required). Data are adjusted by applying the slope and intercept obtained from the linear regression of the appropriate calibration to the monitored data.
- Daily data backups
- Database creation and expansion
- Database archival and retrieval
- Creation of routine data summaries

The automation of these processes ensures that these steps will be performed in a consistent manner that minimizes the potential for processing errors.

Before they are loaded into the database, the data will go through an automatic screening program that will flag any anomalies. The screening routines will check all data for outliers, instrument problems, and data system problems. The screening program will test for data that exceed set minimums, maximums, and rate-of-change values. The data transfer will be reviewed routinely by data management personnel. Data that are lost can be recovered either from the data logger printouts or from the floppy diskette backups.

5.2 DOCUMENTATION AND DATA CUSTODY

All documentation and data pertinent to data processing will be shipped to AVES from the field monthly. The monthly shipment will include site logs, checklist logs, zero/span checks, and multipoint calibration results. Data processing's procedures include checking the shipment for completeness and actions required.

Within one working day of receipt, each form of data and documentation will be logged separately in the incoming data log book for the project. These forms enable prompt identification of missing documentation and allow data clerks to track missing data.

If documents are missing (for example, if a checklist log has not been received from a specific site) or if any problems with the receipt of data arise, the project manager will be informed and he will take appropriate steps to recover the missing information (such as contacting the station operator). A correspondence file will be maintained in AVES's data library to ensure total program documentation; all documentation, including calibration records, data analyses, summaries and reports will be filed there. The data will be filed in appropriately labeled drawers and bins. Once the data and documentation have been received, logged in and filed, they will be available to the data technician to begin processing and validation procedures.

5.3 DATA VALIDATION

All data produced by this project are reviewed before use. AVES data validation procedures start with observations and reports made by the site operator and continue with review and analysis of all logs, checklists and data.

All flagged or anomalous data are investigated. Unless there is substantial evidence that suspect data are erroneous, these data will be retained. AVES's data processing procedures allow only the project's principal investigator (the project manager for this program) to invalidate data.

Zero and span check data for the hydrocarbon analyzers are reviewed routinely as part of the data validation effort. Data collected during periods when the span response deviates by more than 25 percent or the zero response deviates by more than 0.025 ppm from true values are invalidated. Data collected during periods when the span response deviates between 15 percent and 25 percent or the zero response deviates between 0.015 and 0.025 ppm are adjusted using correction factors obtained from the calibration and zero/span checks. The zero/span checks will be used to determine the affected period and the correction factors used to adjust the values.

All changes resulting from review of the documentation will be made directly on the raw data report and comments added as necessary to explain the changes. The raw data reports will be reviewed to ensure that all outliers have been corrected, replaced by the proper missing data code, or checked off as valid. Once the raw data have been completely checked, corrected and signed off by the quality control coordinator, changes will be made to the database and any necessary correction factors applied.

5.4 FIELD AND LABORATORY PROCEDURES USED TO ASSESS DATA ACCURACY, PRECISION, AND COMPLETENESS

Data collected during the program will be identified, validated, and reported. When data are reduced, the method of reduction will be described in the text of the report. Restraints on statistical inferences will be stated.

Pacific standard time will be referenced during data collection. All field measurement, meteorological, and laboratory data will be reported consistently, in accepted standard units.

The data will be assessed for accuracy, precision and completeness using the procedures described in the following subsections.

5.4.1 Accuracy

Accuracy is the difference between the analyzer response and the reference value obtained during the multipoint instrument audit.

$$\text{Accuracy} = \frac{Y - X}{X} \times 100$$

where: Y = analyzer value
X = the true concentration as determined by the audit.

5.4.2 Precision

Method precision will be determined from the weekly precision checks. The calculation to be used is provided in EPA (1987).

5.4.3 Completeness

For the field sampling and laboratory analyses, completeness is calculated as the ratio of acceptable measurements obtained to the total number of planned measurements. This ration does not include downtime due to routine zero span and precision checks, calibrations or

audits. Loss of data due to these operations will be minimized to the extent possible through management of the time of when they take place.

SECTION 6

PERFORMANCE AND SYSTEM AUDITS

The objectives of an auditing program are to ensure the integrity of the data and to assess the accuracy of the data. Two types of audits are included in an auditing program: systems audits and performance audits.

A systems audit is an independent qualitative evaluation of the ability of an operation to generate quality data. Systems audits are conducted to evaluate all field, data processing, internal reporting, and analysis activities. A systems audit will be performed by a member of AVES's QA Department. The auditor will check that standard procedures are being followed. Additionally, he will inspect copies of data, calibration factors, and problem reports to verify that correct protocols have been observed.

A performance audit is an independent quantitative evaluation of the quality of data produced by the total measurement system, including sample collection, sample analysis and data processing. It is an assessment of the measurement process under normal operations. A performance audit will be performed by a AVES QA engineer two weeks after the start of field sampling. The performance audit will include multipoint audits of all analyzers and measurement instrumentation. Audit results will be compared against the measurement goals for accuracy presented in the previous sections.

The audit procedures will conform to guidelines described in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I (1984) and II (1987b). Procedures are discussed below. Other relevant guidelines are outlined in the EPA Ambient Air Quality Surveillance Regulations 40 CFR 58, Appendices A through E. All instruments and materials used to perform the audits will be traceable to the National Institute of Standards and Technology (NIST). A trained quality assurance engineer will perform each audit. Each member of the AVES quality assurance staff is experienced in on-site audits and in-the-field quality assurance procedures for air monitoring programs.

6.1 AUDIT EQUIPMENT

- **Dilution Systems**

The AVES QA Department designated audit calibration units are a Dasibi Model 5009 MC and a Dasibi Model 1009 MC dilution system. Mass flow rates are certified quarterly using a Meriam laminar flow element, which is a transfer standard for mass flow. AV's primary flow device is a NIST-certified Bubble-O-Meter. Both the Meriam and Bubble-O-Meter are housed in the AV QA standards laboratory in Monrovia, California. The audit calibration units are certified once per quarter.

- **Audit Span Gases**

Audit gases are analyzed in accordance with the Traceability Protocol for Establishing True Concentrations of Gases Used for Calibrations and Audits of Air Pollution Analyzers (Protocol No. 2), May 1987, in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Section 2.0.7. All cylinders are recertified every six months. Cylinder gases used by AVES are supplied by Scott-Marrin, Inc., Riverside, California.

- **Ultrapure Air Cylinders**

Ultrapure air is used in the performance of the audits of the continuous THC and CO analyzers. Ultrapure air cylinders are obtained from Scott-Marrin, Inc. when the pressure in the cylinder currently in use drops to 300 lb/in^2. Each ultrapure air cylinder, with the exception of that used to audit the CO_2 analyzer, contains a concentration of 350 ppm CO_2 to simulate ambient air conditions.

- **Ozone Transfer Standard**

The EPA technical assistance document, Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone (September, 1979), EPA-600/4-79-056 has been adopted by the AV QA department as the guideline for certification and recertification of ozone primary and transfer standards.

The AV QA primary ozone standard is a Dasibi 1003 RS. Comparison of AV QA's primary standard with an EPA standard photometer is performed once per year. The QA Department's designated ozone transfer standards are a Dasibi 5009 MC Serial Number 281 and a Dasibi 1003 PC Serial Number 5311. These ozone analyzers were converted to a transfer standard configuration in accordance with EPA guidelines (September, 1979). Ozone analyzers that are converted to a transfer standard configuration must be compared to the AV primary ozone standard by means of a 6 x 6 comparison as the final step in the conversion process. Ozone transfer standards that are in regular use must be compared by means of a 1 x 8 (zero and seven upscale concentration points) comparison with the AV primary ozone standard twice per quarter.

- **Temperature Sensors**

Mercury-in-glass thermometers are compared to the AV QA department's NIST-traceable thermometer by an eight-point calibration before their first use in the field. All thermometers are referenced to this thermometer which is an NIST-traceable Brooklyn thermometer, Serial number 6D619. All field thermometers are recertified each year.

- **Laminar Flow Elements**

Laminar flow elements are maintained by AVES's Quality Assurance Department as a secondary standard. All laminar flow elements are certified annually by an external laboratory.

- **Meteorological Instrument Audit Equipment**

The device AV uses to audit horizontal and vertical wind speed sensing systems is an RM Young Model 18810 Selectable Speed Anemometer drive. Its rotational velocities are certified quarterly using a Cole-Parmer Model 8211 Phototach.

The wind direction boom alignment is checked with a Brunton Compass. There is no certification procedure for compasses. The compass is checked for damage before each use.

The relative humidity and dew point audit device is a Psychro-Dyne psychrometer. The wet and dry bulb thermometers of the psychrometer are certified by comparing there readings with

an NIST-traceable Brooklyn thermometer, Serial number 6D619. The psychrometer is recertified each year.

6.2 PERFORMANCE AUDIT PROCEDURES

As stated previously, AVES conducts performance audits in accordance with procedures described in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I (1984) and II (1987b).

- **CO, CO_2 and NMHC Analyzers**

A multipoint audit will be performed to obtain the analyzer's response to a known input. The audit will be performed by diluting gas concentrations obtained from standard gas cylinders of CO, CO_2 and methane using the Dasibi calibrator. This audit will provide the analyzer response at three evenly spaced span points covering the entire analyzer range and the zero point. The procedures follow the EPA-recommended methods (EPA, 1987b) and are described briefly below.

The audits of the air quality samplers begin with the station technician identifying the appropriate data channel and taking it off line so that ambient data are no longer being collected. The sample line or inlet filter is then connected to the Dasibi calibrator via a vented "T" arrangement that introduces the audit span gas through as much of the normal sampling train (i.e., filters, scrubbers, etc.) as possible. The analyzers are challenged with specific concentrations of span gas as follows:

Audit Point	Concentration Range (Percent of scale)
1	.0
2	6% to 16%
3	30% to 40%
4	70% to 90%

- **Temperature**

The temperature-sensing systems are audited by immersing the system thermister together with an NIST-traceable mercury-in-glass thermometer in the same water bath and comparing the readings of the thermometer with the DAS at three temperatures across the normal operating range of the system.

- **Flow Meters**

The performance of ROOTS® meters and other any other flow devices will be audited using an appropriate laminar flow element (LFE). The LFE will be placed in-line with the Roots meter. Measured audit flow rates will be compared the flow rates supplied by the site technician. Site comparison flow rates should correspond to the flow rates used to calculate sample concentrations. The ambient temperature and atmospheric pressure will be recorded for each flow rate audited, allowing audit flow rates to be reported in either volumetric or standard units, using the following equations:

$$Q_{std} = Q_{vol} \times (P_a / 29.92) \times (298 / T_a)$$

$$Q_{vol} = Q_{std} \times (29.92 / P_a) \times (T_a / 298)$$

where Q_{std} is the flow rate at standard conditions (P = 29.92" Hg, T = 298°C)
Q_{vol} is the volumetric flow rate
P_a is the ambient pressure in inches of Hg
T_a is the ambient temperature in °C

- **Relative Humidity**

Relative humidity is audited by calculating the equivalent station dew point temperature from the station relative humidity and temperature readings and comparing this value with the audit dew point temperature. The audit dew point temperature is calculated from measurements of the wet bulb and dry bulb temperatures of the NIST-traceable thermometers installed in a Psychro-Dyne motorized psychrometer and the barometric pressure provided by a Peet Brothers, Ultimeter Model 3 electronic barometer.

- **Pressure Transducers**

Output from the pressure transducers will be audited by teeing in an incline manometer and comparing the transducer reading with the manometer reading

- **Barometric Pressure**

Barometric pressure sensors are audited by a one-point ambient comparison with an audit barometer. The audit barometer is a Peet Brothers Ultimeter Model 3 electronic altimeter/barometer.

- **Data Acquisition System**

Audit of the strip chart recorders and data loggers will be performed as part of the instrumentation audit. Since all instrument audit responses are synonymous with data system response, data system responses are audited as the various instruments interfaced with the data system are audited. The strip chart recorders and data loggers will be checked for proper data scanning frequency and clock time.

6.3 SYSTEMS AUDIT

AVES's quality assurance department will perform a systems audit in conjunction with the performance audit. The EPA has established guidelines for installing and operating air monitoring programs to assure the collection of accurate, complete, and precise data (EPA, 1987). In addition, vapor recovery test procedures are specified in TP-201 (CARB, 1996). A systems audit verifies that these guidelines and procedures are being adhered to and that data of acceptable quality can be collected. It is a qualitative appraisal of the quality assurance/quality control systems used for each monitoring sensor.

During the systems audit, the overall organization and operation of the monitoring program is examined. This includes evaluating sample flow requirements, sampling probe location, calibration and instrument check procedures, data-processing procedures, instrument operating range, and quality control procedures and methods. In addition, system components will be

checked for conformity with TP-201 procedures. The audit will be performed using a checklist to document audit findings and provide a standardized method for performing the systems audit.

Upon completion of the systems audit, the auditor will prepare a report detailing deficiencies found during the audit. In the report, he will, if necessary, recommend actions required to improve the project and to meet regulatory agency guidelines. Included in the report will be copies of the systems audit checklist.

Quality assurance will be performed by AVES's Quality Assurance (QA) department. The QA department is an independent section of AV and reports findings directly to the project manager. QA will include both a system audit and a performance audit.

SECTION 7

REPORTING

7.1 DATA REPORTING

After each of the major uncontrolled test series (e.g., fall, winter, spring and summer) preliminary data reports will be prepared by AVES and sent to AVES project manager. The data report will include a description of the measurements and data precision, completeness and blank filter analysis results.

At the end of the uncontrolled test series field program, the preliminary data will undergo further validation in preparation for data analysis. Upon completion of this validation task, data analysis will be executed. The results of this effort will be summarized in a project progress report and sent to the technical advisor panel.

At the conclusion of the controlled test series, preliminary data reports will be prepared by AVES and sent to AVES project manager. As with the uncontrolled tests series, the data report will include a description of the measurements and data precision, completeness and blank filter analysis results. At this point, a final data validation exercise will be performed followed by data analysis of the controlled data test series.

At the conclusion of all data analysis activities, a draft final report will be completed and submitted to the TAP for review in a format specified by ARB. Upon receiving their comments, the project final report will be completed.

Monthly progress reports will be send to the ARB project manager describing progress to date, expected action items for the following month, and problems or concerns.

SECTION 8

CORRECTIVE ACTION

Corrective action will be initiated whenever a problem is identified. The goal of corrective action is to remedy any problem before the project or equipment and/or parameters drop below the desired accuracy, precision, or completeness.

The data polling scientist or instrument technician are the primary individuals on this project for identifying problems and initiating corrective action. The local site operator is secondary on this project for identifying most problems except for those problems that can only be identified by visual site inspection. Once a problem has been identified, the person who found it will either fix it himself or request the project manager for assistance.

Whenever a problem is identified, the project manager will be notified. A computerized copy of the action report will be filled out using AVES's computerized problem reporting system. The problem reporting system assures completeness of documentation and automatically notifies (computer mail) all project personnel about the problem. The project manager is responsible for appropriate action to maintaining the monitoring objective. For instance, in order to maintain the 80 percent hydrocarbon sampling completeness goal, if the data poller or site operator find the analyzer inoperative, the project manager will take action to prevent more than six days of lost data in a month.

SECTION 9

SCHEDULE

9.1 STUDY SCHEDULE

The proposed schedule for the uncontrolled and controlled test series are illustrated in Table 9-1.

ble 9-1
Timeline
Vapor Recovery Systems at Gasoline Dispensing Facilities
Season Effects

	February		March			April				May				
	22-Feb	1-Mar	8-Mar	15-Mar	22-Mar	29-Mar	5-Apr	12-Apr	19-Apr	26-Apr	3-May	10-May	17-May	24-May	31-May
Test #1 Balance Site Uncontrolled Test Series Fall															
Test #2 Gilbarco Site Uncontrolled Test Series Fall															
Test #3 Exempt Site Uncontrolled Test Series Fall															
Test #4 Balance Site Uncontrolled Test Series Winter															
Test #5 Gilbarco Site Uncontrolled Test Series Winter															
Test #6 Exempt Site Uncontrolled Test Series Winter															
Test #7 Balance Site Uncontrolled Test Series Spring															

Table 9-1
Timeline
Vapor Recovery Systems at Gasoline Dispensing Facilities
Season Effects

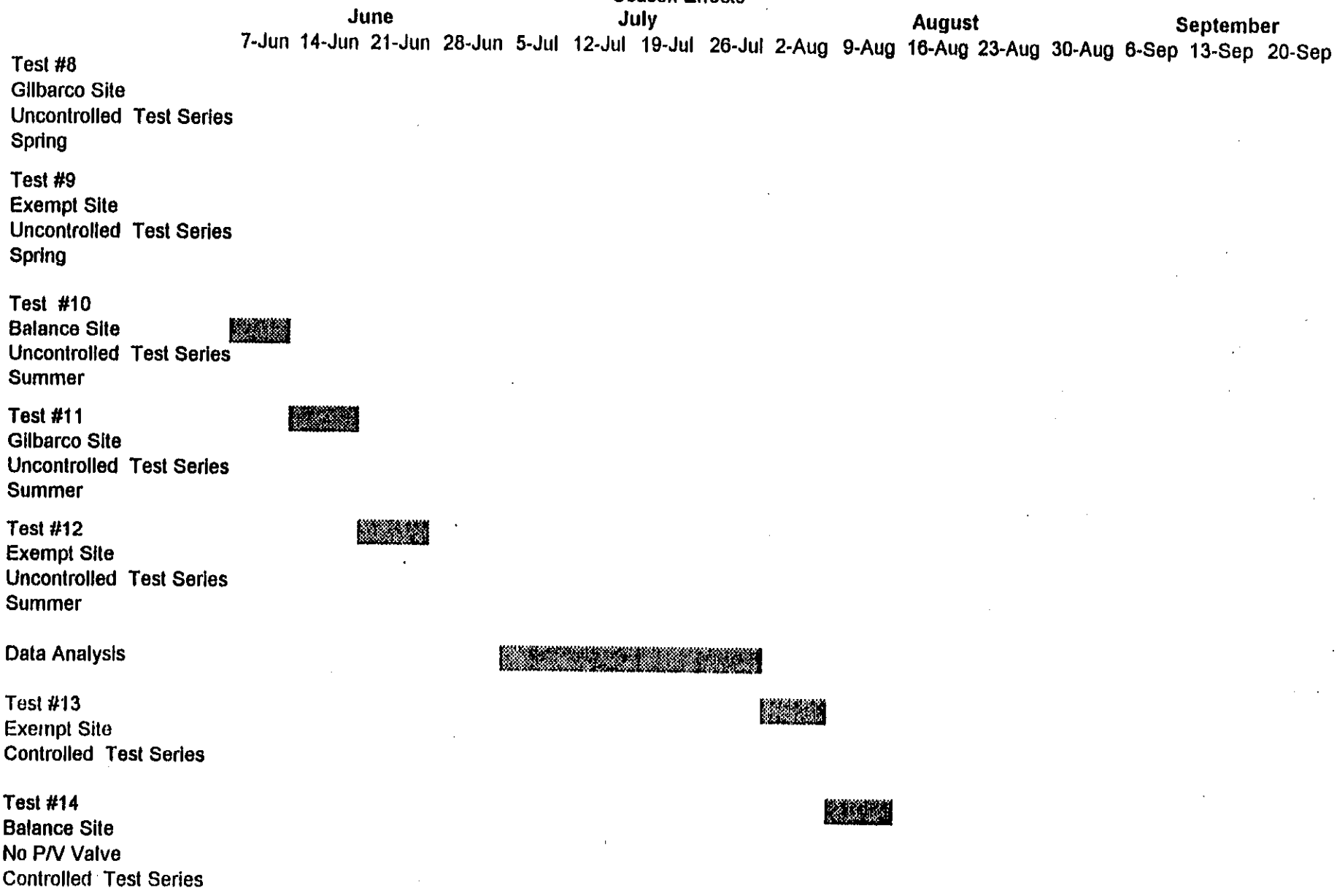


Table 9-1
Timeline
Vapor Recovery Systems at Gasoline Dispensing Facilities
Season Effects

	October					November					December			
	27-Sep	4-Oct	11-Oct	18-Oct	25-Oct	1-Nov	8-Nov	15-Nov	22-Nov	29-Nov	6-Dec	13-Dec	20-Dec	27-Dec
Test #15 Balance Site With P/V Valve Controlled Test Series														
Test #16 Gilbarco Site Controlled Test Series														
Test #17 Dresser Wayne Site Controlled Test Series														
Test #18 Hasstech Site Controlled Test Series														
Test #19 Hirt Site Controlled Test Series														
Test #20 Healy Site Controlled Test Series														
Data Analysis														

SECTION 10

REFERENCES

40 CFR 58 (1987): Code of Federal Regulations: Protection of the Environment, Title 40, Parts 53 to 60.

Environmental Protection Agency: QA/QC Requirements for Reviewing the Data Generated by Responsible Parties. Unnumbered and undated EPA document.

Environmental Protection Agency (1987a): Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). EPA Document EPA-450/4-87-007.

Environmental Protection Agency (1987b): Quality Assurance Handbook for Air Pollution Measurement Systems Vol. II, Ambient Air Specific Methods. EPA Document EPA-600/4-77-027a.

Environmental Protection Agency (1984): Quality Assurance Handbook for Air Pollution Measurement Systems. Vol. I, Principles. EPA Document EPA-600/9-76-005.

Environmental Protection Agency (1980): Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. EPA Document QAMS-005/80.

Appendix A

TP-201.1

DETERMINATION OF EFFICIENCY OF PHASE I VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES WITHOUT ASSIST PROCESSORS

California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.1

Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors

Adopted: April 12, 1996

California Environmental Protection Agency
Air Resources Board

Vapor Recovery Test Procedure

TP-201.1

Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors

1 APPLICABILITY

A set of definitions common to all certification and test procedures is in:

D-200 Definitions for Certification Procedures and Test Procedures for Vapor Recovery Systems

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

1.1 General Applicability

This procedure is used to quantify the Phase I volumetric efficiencies during bulk gasoline deliveries at gasoline distribution facilities (GDF). It is applicable for the determination of compliance at those facilities which are not equipped with an assist processor (e.g. Hirt or Hasstech Phase II systems are equipped with an assist processor). Assist systems actively pump vapors to processors which control emissions by burning, adsorbing, or condensing hydrocarbon vapors. The active pump in the system and the emissions point at the processor outlet in addition to the vent require additional steps in the test procedure.

1.2 Modifications

Modification of this procedure may be necessary for vapors and fluids other than the hydrocarbon vapors associated with the dispensing of gasoline.

Any modification of this method shall be subject to approval by the ARB Executive Officer.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

During a bulk gasoline delivery, the volume of gasoline delivered from the cargo tank to the GDF storage tank is recorded. The volume of gasoline vapor discharged from the vent pipe(s) of the storage tank(s) is measured. From these parameters the Phase I volumetric efficiency is determined.

If a Phase I system fails to meet 95% volumetric efficiency, the gasoline cargo tank shall be tested, pursuant to TP-204.2, to determine compliance with the daily performance standards for gasoline cargo tanks. For this application, TP-204.1 and TP-204.3 are inappropriate.

3 BIASES AND INTERFERENCES

3.1 Bulk Delivery Vapor Leaks

Any vapor leak exceeding 21,000 ppm (as propane), during the gasoline bulk delivery, precludes the use of this method.

3.2 Cargo Tank Performance

Gasoline cargo tanks exceeding the static pressure performance standards (see CP-204) preclude the use of this method.

4 SENSITIVITY, RANGE, AND PRECISION

The minimum readability of the pressure gauges shall be 0.1 inches of water column.

The minimum accuracy of the pressure gauges shall be 2 % of full scale.

5 EQUIPMENT

5.1 Positive Displacement Meter(s)

Use rotary type positive displacement meter(s) with a back pressure limit (BPL) less than:

1.10 inches water column at a flowrate of 3,000 CFH down to
0.05 inches water column at a flowrate of 30.0 CFH.

Meter(s) shall be equipped with taps accomodating the following equipment:

(1) taps on the inlet side for

(a) a thermocouple with a range of 0 to 150 °F and

(b) a pressure gauge with a range providing absolute pressure readings within 10 to 90% of the range (more than one gauge shall be used, if necessary) and

(2) taps on the inlet and outlet sides for a differential pressure gauge with a range of 0 to < 2x BPL (i.e. full scale shall be less than twice the back pressure limit).

5.2 Tubing

Use 2.5 inch ID "flexhaust" tubing, or equivalent, to connect the vent pipe outlet to the inlet of the rotary positive displacement meter. The length of the tubing shall be the minimum required for proper connection.

5.3 Cargo Tank Pressure Assembly

Use Civicon 633-F and 633-D couplers, or equivalent, as shown in Figure 1. The assembly shall be equipped with a thermometer and a pressure gauge, or manometer(oil or water), capable of measuring -10 to +10 inches water column pressure at the gasoline cargo tank vapor coupler.

5.4 Storage Tank Pressure Assembly

For two-point Phase I systems, use a compatible OPW 634-B cap(s), or equivalent, equipped with a 0 to 0.5 inches water column pressure gauge and a center probe as shown in Figure 2. This equipment is only required if a test is conducted on a manifolded vapor recovery system.

5.5 Combustible Gas Detector

Use a Bacharach Instrument Company Model 0023-7356, or equivalent, to quantify any vapor leaks occurring during the gasoline bulk drop.

5.6 Barometer

Use a mercury, aneroid, or equivalent barometer accurate to within 5 millimeters of mercury (0.2 inches of mercury).

5.7 Thermometers

Use three thermometers, or equivalent, with a range of 0 to 150 °F and accurate to within 2 °F.

5.8 Stopwatch

Use a stopwatch accurate to within 0.2 seconds to time the delivery rate of gasoline during the bulk drop.

6 CALIBRATION PROCEDURE

A record of all calibrations shall be maintained.

6.1 Analyzers

Follow the manufacturer's instructions concerning warm-up time and adjustments. On each test day prior to testing, zero the analyzer with a zero gas and span with a known concentration of calibration gas at a level near the highest concentration expected. Perform an intermediate zero and span calibration approximately 2 hours after the initial calibration and at any time a calibration drift is evident. Check for zero and span calibration drift at the end of the test period. All calibrations and adjustments shall be documented.

6.2 Volume Meters

Meters shall be calibrated on an annual basis.

6.3 Pressure Transducers

Calibrate pressure transducers prior to testing and immediately following the test period with a static pressure calibrator for a range of -3 to +3 inches water or appropriate range of operation.

6.4 Temperature Transducers

Calibrate temperature transducers every six months using ambient air, the temperature of which is determined by a NIST traceable mercury-glass thermometer.

7 PRE-TEST PROTOCOL

7.1 Location of Test Site

Prototype systems will be located within 100 miles of Sacramento for testing. Other locations may be accepted at the discretion of the ARB Executive Officer.

7.2 Specification of Test, Challenge, and Failure Modes

The specification of test, challenge, and failure modes such as the number of liquid transfer episodes, volume and volumetric rate of liquid transfer, storage tank volumes, etc. shall be done according to the principles of CP-201 § 5 for the testing and evaluation of vapor recovery equipment.

7.3 **System and Facility Preparation**

System equipment and components shall be completely operational and any storage tanks involved in the test shall be filled to the appropriate volume a minimum of 24 hours prior to the scheduled test.

In addition, the system and facility shall be prepared to operate according to any specified test, challenge, and failure modes.

7.4 **Specific Pre-Test Protocol Items**

(1) **Visual Inspection**

Perform a visual inspection of all storage tank couplers. Inspect all vapor connections at the gasoline dispensers if Phase II vapor recovery is present.

(2) **Meter Connections**

Connect the positive displacement meter to the appropriate storage tank vent pipe using the flexible tubing. If a non-manifolded delivery consists of simultaneous delivery of more than one product grade, connect one positive displacement meter to each storage tank vent pipe.

(3) **Phase I Vapor Recovery Data Sheet**

(a) Record the gas grade, capacity, and ullage for each storage tank on the Phase I Vapor Recovery Data Sheet shown in Figure 3.

(b) Record, on the Phase I Vapor Recovery Data Sheet, the initial meter readings from the positive displacement meter.

(c) Record, on the F Vapor Recovery Data Sheet, the barometric pressure.

(4) **Cargo Tank Vapor Assembly Connection**

Connect the Cargo Tank Vapor Assembly to the vapor coupler on the gasoline cargo tank. If the cargo tank vapor coupler is equipped with a poppet, be sure to use a pressure assembly with a center probe.

(5) **Storage Tank Pressure Assembly Connection**

If a manifolded vapor recovery system with a two-point Phase I system is being tested, install a Storage Tank Pressure Assembly on the Phase I vapor connections of those tanks not receiving product. During each bulk drop record the maximum pressure in those tanks. For coaxial systems the pressure may be measured at the dispensers.

7.5 Ensure that no vehicle refueling will occur during the bulk gasoline delivery.

8 TEST PROCEDURE

The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

8.1 General Data Collection

Record, on the Phase I Vapor Recovery Data Sheet, the gasoline grade(s) and quantities delivered during each bulk drop. Also record the cargo tank CT#, ARB decal number and expiration date, and the cargo tank compartment capacities.

8.2 Chronometric Data

Start the stopwatch when the bulk delivery begins and stop the stopwatch at the conclusion of the delivery. If possible, the delivery rate shall be determined for each cargo tank compartment.

8.3 Data Collection

Record the following parameters every 15 seconds during each gasoline bulk drop:

8.3.1 Phase I Vent Pipe Data Sheet

Meter readings, temperatures, and pressures at the positive displacement meter. Extreme care must be taken to record all positive displacements since occasional reverse flow conditions may occur. Record this data on the Phase I Vent Pipe Data Sheet shown in Figure 4.

8.3.2 Phase I Cargo Tank Data Sheet

Vacuum (or pressure) and temperature at the cargo tank pressure assembly attached to the cargo tank vapor coupler. Record this data on the Phase I Cargo Tank Data Sheet shown in Figure 5.

8.4 Continuous Monitoring

Continue to monitor the vent pipe emissions for a period of one hour after the bulk drop has been completed. During this one hour period the data collection required in § 8.3.1 shall be recorded at 5 minute intervals. These emissions are to be included in the Phase I efficiency calculation.

8.5 After the Bulk Drop

After the conclusion of the bulk drop:

(1) remove the Cargo Tank Pressure Assembly from the cargo tank and the Storage Tank Pressure Assembly(s) from the storage tank(s);

(2) disconnect all instrumentation from the storage tank vent pipe(s) after concluding the one hour post-drop portion of the test;

(3) verify the quantities of gasoline delivered to each storage tank;

(4) record the final meter reading(s) at the storage tank vent pipe(s).

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

This section is reserved for future specification.

10 RECORDING DATA

This section is reserved for future specification.

11 CALCULATING RESULTS

Note: In addition to other required calculations, vapor recovery system test results shall be calculated in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

11.1 Volume of Vapors Discharged through "i^{th}" Vent

This includes the storage tank vent(s) and any control system vent(s).

$$V_{vsi} = \frac{V_{vi} \times 528 \left[P_b + \frac{\Delta h}{13.6}\right]}{T_{vi} \times 29.92}$$

Where:

V_{vsi} = total volume of vapors discharged through the "i-th" vent pipe, corrected to 68°F and 29.92" Hg; SCF.

P_b = barometric pressure; inches Hg.

V_{vi} = total volume of vapors discharged through the "i-th" vent; ACF.

T_{vi} = average temperature in "i-th" vent line; °R

Δh = average pressure at meter; inches H_2O and

i = vent under consideration.

11.2 Volume of Vapors Returned to the Cargo Tank:

$$V_t = \frac{0.1337 \times G_t \times 528 \left[P_b + \frac{\Delta H}{13.6}\right]}{T_t \times 29.92}$$

Where:

V_t = volume of vapors returned to the cargo tank corrected to 68°F and 29.92" Hg; SCF.

G_t = volume of gasoline delivered; gallons.

ΔH = final gauge pressure at cargo tank; in. H_2O.

T_t = average temperature of vapors returned to cargo tank; °R.

P_b = barometric Pressure; inches Hg.

0.1337 = conversion factor; gallons to ft^3.

11.3 Collection Efficiency

$$E = \frac{V_t - V_{vsi}}{V_t} \times 100$$

Where:

E = Phase I volumetric efficiency; percent.

V_t = see 11.2.

V_{vsi} = see 11.1.

12 REPORTING RESULTS

Note: In addition to other required results, vapor recovery system test results shall be reported in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

Results shall be reported as shown in Figure 6.

13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.

(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

TP-201.1A Determination of Efficiency of Phase I Vapor Recovery Systems with Assist Processors

This procedure applies when the operation of an assist processor precludes testing by TP-201.1.

14 REFERENCES

This section is reserved for future specification.

15 EXAMPLE FIGURES AND FORMS

15.1 Figures

Each figure provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the figures are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

Figure 1
Test Locations

Figure 2
Storage Tank Test Point 1
Storage Tank Pressure Assembly

Figure 3
Vapor Return Test Point 2
Cargo Tank Pressure Assembly

Figure 4
Vent Test Point 3
Single Vent (Volume Measurement)

Figure 5
Vent Test Point 3
Manifolded Vents (Volume Measurement)

15.2 Forms

Each form provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the forms are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

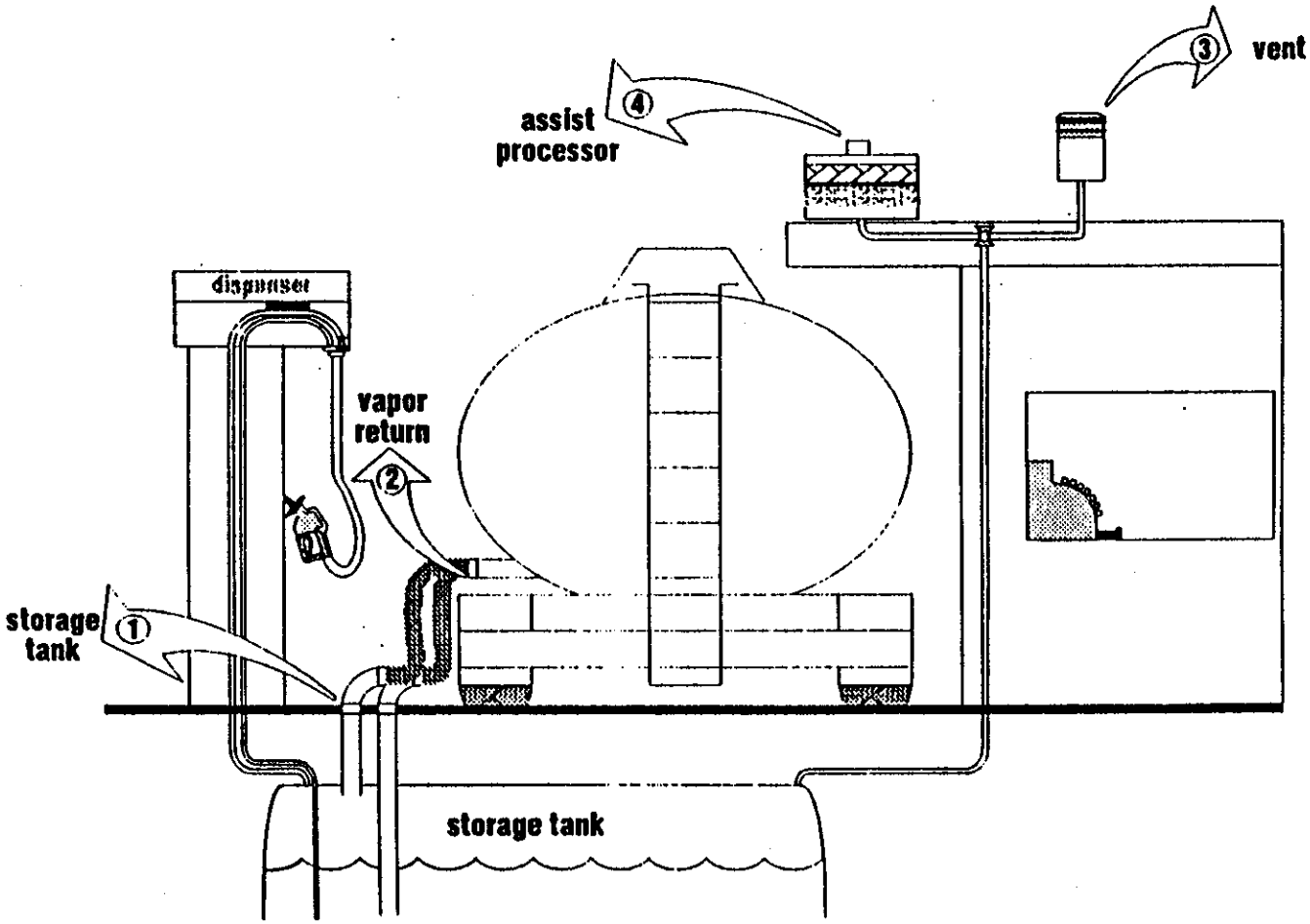
Form 1
Phase I Vapor Recovery Data Sheet

Form 2
Phase I Vent Pipe Data Sheet

Form 3
Phase I Cargo Tank Data Sheet

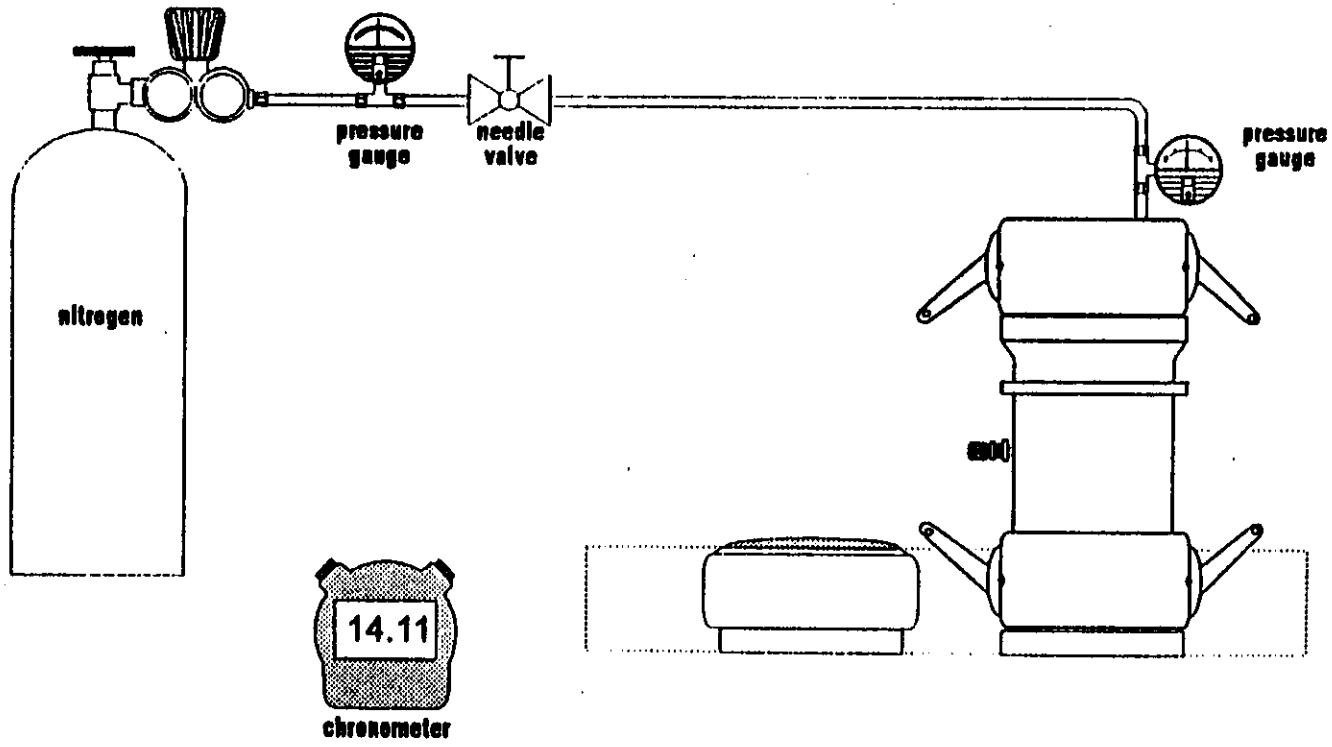
Form 4
Reporting Results

FIGURE 1
Test Locations



TP 201.1 F.V.R. CORDOVA '95

FIGURE 2
Storage Tank Test Location 1
Storage Tank Pressure Assembly



TP 201.1 F.2/ B. CORDOVA '06

FIGURE 3
Vapor Return Test Location 2
Cargo Tank Presssure Assembly

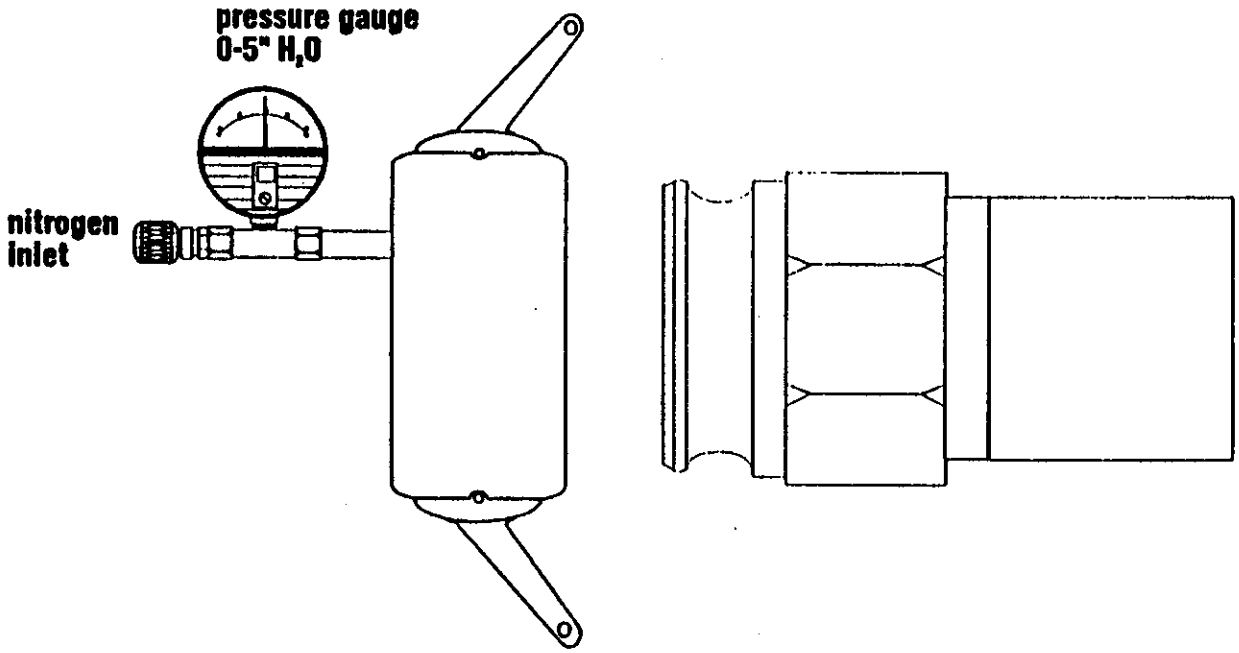
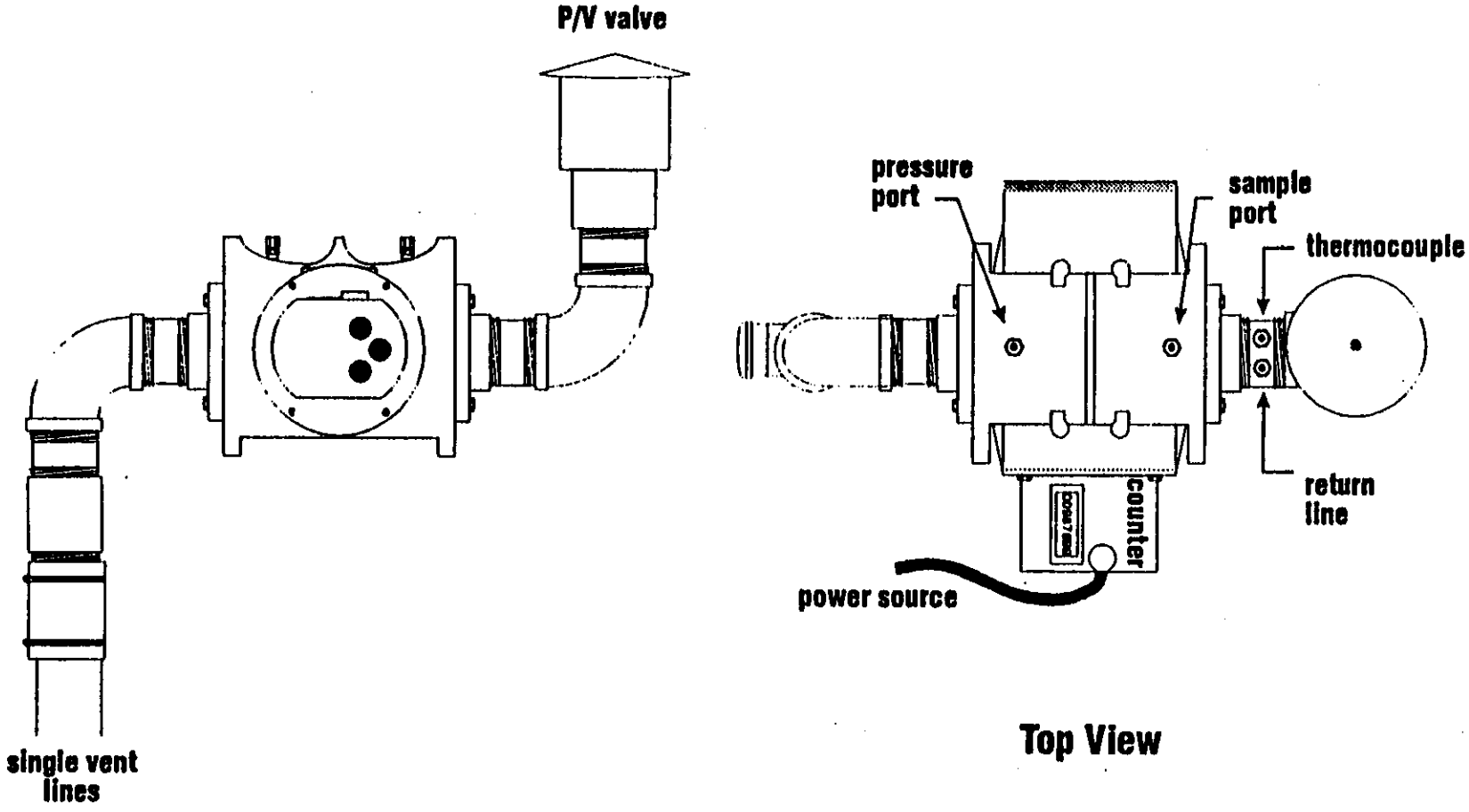
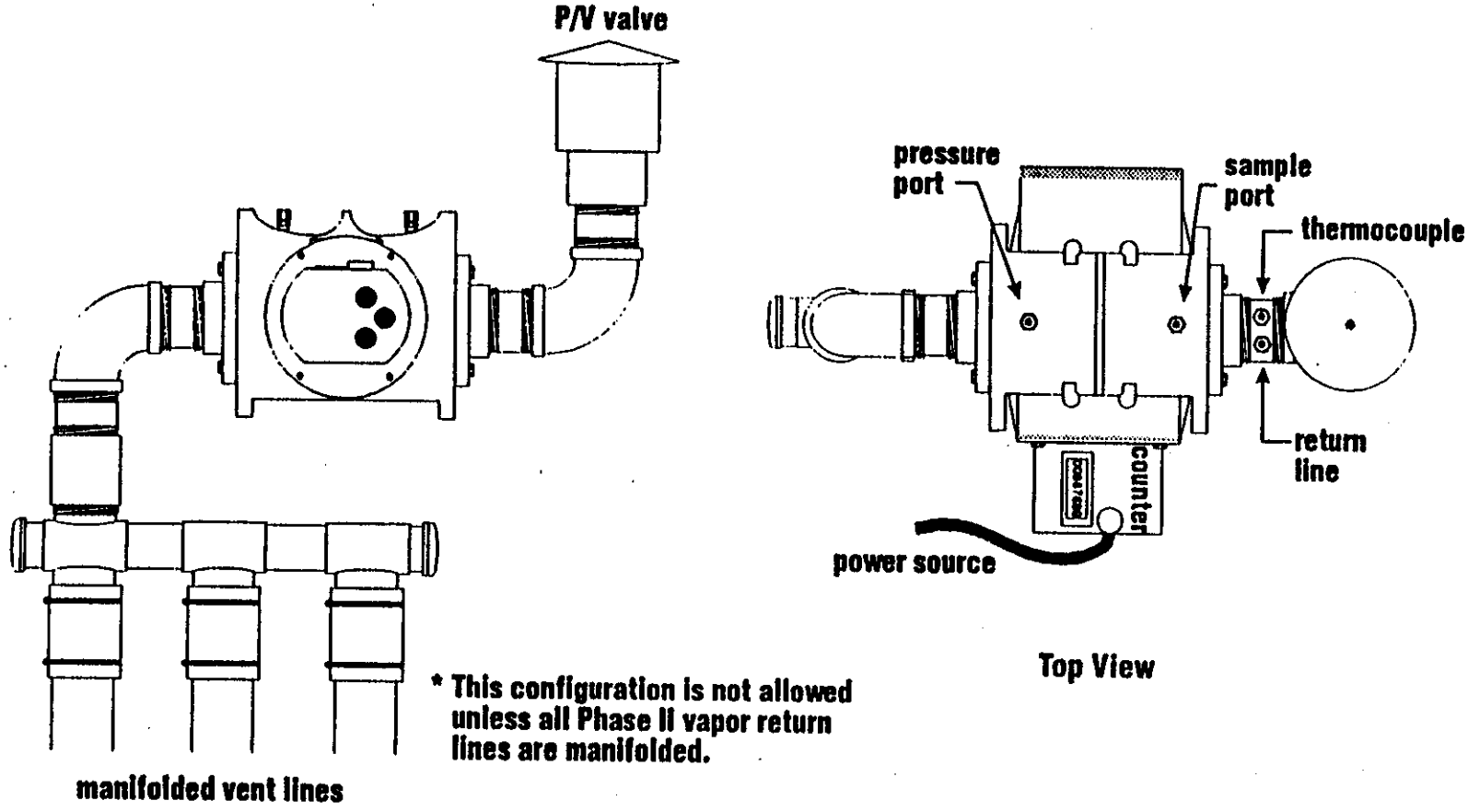


FIGURE 4
Vent Test Location 3
Single Vent (Volume Measurement)



TP 201.1 F-V B. CORDOVA '96

FIGURE 5
Vent Test Location 3
Manifolded Vents (Volume Measurement)



TP 201.1 F.S/ B. CORDOVA '96

FORM 1
Phase I Vapor Recovery Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Vapor Return Manifold (Y/N) ..... ΔP - Dry Bake Closed .....

Number of Vent Pipes ..... Vent Manifold (Y/N) ..... ΔP - Dry Bake Open .....

PARAMETER / TEST NUMBER	1	2	3	4
1. Ambient Temperature, °F				
2. Barometric Pressure, "Hg				
3. Gasoline Grade				
4. U.G. Tank Size, gallons				
5. Initial U.G. Tank Content, gallons				
6. Time Delivery Began/Vent Meter Reading				
7. U.G. Tank Vapor Temperature, °F				
8. Vent Vapor Temperature, °F				
9. Vent Meter Pressure, "H_2O				
10. Volume Delivered, gallons				
11. Time Delivery Ended/Vent Meter Reading				
12. Drop Flowrate, gallons per minute				
13. Volume of Vent (VOV) Emissions, SCF				
14. Volume of Vapors Returned to Cargo Tank, SCF				
Vapor Recovery Volumetric Efficiency, %				

$$\text{Vapor Recovery Volumetric Efficiency} = \frac{\#14 - \#13}{\#14} \times 100\%$$

TEST PERSONNEL .....

.....

FORM 2
Phase I Vent Pipe Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Number of Vent Pipes ..... Test Times .....

Vent Manifold (Y/N) ..... Vapor Return Manifold (Y/N) ..... Vent Valve (Y/N) .....

Bulk Drop ID ..... Grade(s) Dropped ..... Gallons(s) Dropped .....

TIME	$V_{AIR\ \&\ VAPOR}$ SCF	ΔP "H_2O	T °F	TIME	$V_{AIR\ \&\ VAPOR}$ SCF	ΔP "H_2O	T °F
1 min				4 min			
2 min				5 min			
3 min				6 min			

TEST PERSONNEL .....

.....

FORM 3
Phase I Cargo Tank Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Number of Vent Pipes ..... Test Times .....

Vent Manifold (Y/N) ..... Vapor Return Manifold (Y/N) ..... Vent Valve (Y/N) .....

Bulk Drop ID ..... Grade(s) Dropped ..... Gallons(s) Dropped .....

TIME	$V_{LIQUID\ FUEL}$ GALLONS	ΔP "H_2O	TEMP. °F	TIME	$V_{LIQUID\ FUEL}$ GALLONS	ΔP "H_2O	TEMP. °F
1 min				4 min			
2 min				5 min			
3 min				6 min			

TEST PERSONNEL .....

.....

FORM 4
Reporting Results

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Summary of Test Results for
(Phase I Volumetric Efficiency of Service Stations)

California Environmental Protection Agency, Air Resources Board: Vapor Recovery Test Procedure TP-201.1

Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors

Bulk Drop ID				
Volume of Air &Vapor Emitted from Vent, SCF				
Volume of Vapors Returned to Cargo Tank, SCF				
Individual Vapor Recovery Volumetric Efficiency Test Results, %				
Average Vapor Recovery Volumetric Efficiency Test Result, %				
Required Vapor Recovery Volumetric Efficiency, % (by Local Regulation)				
Compliance Status (circle one)			**NO**	**YES**

Summary of Attachments	Indicate Absence in this Column	Indicate Number in this Column
Phase I Vapor Recovery Data Sheet(s)		
Phase I Vent Pipe Data Sheet(s)		
Phase I Cargo Tank Data Sheet(s)		
Technical Evaluation and Calculations		
Technical Suggestions for Improved Compliance		

Appendix B

TP-201.2

DETERMINATION OF EFFICIENCY OF PHASE II VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES

California Environmental Protection Agency
Air Resources Board

Vapor Recovery Test Procedure

TP-201.2

Determination of Efficiency of Phase II Vapor Recovery Systems of Dispensing Facilities

1 APPLICABILITY

A set of definitions common to all certification and test procedures is in:

D-200 Definitions for Certification Procedures and Test Procedures for Vapor Recovery Systems

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

1.1 General

This procedure applies to the determination of Phase II vapor recovery system efficiency at dispensing facilities by mass balance principles. This procedure applies to any vapor emissions associated with the dispensing of any fluid, although it is written to reflect application to the hydrocarbon (HC) vapors associated with the dispensing of gasoline.

1.2 Modifications

Modification of this procedure may be necessary for vapors and fluids other than the hydrocarbon vapors associated with the dispensing of gasoline.

Any modification of this method shall be subject to approval by the ARB Executive Officer.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The purpose of this test procedure is to determine the percent vapor recovery efficiency for a vapor recovery system at a dispensing facility. The percent vapor

recovery efficiency is the percent of vapors displaced by dispensing which are recovered by a vapor recovery system rather than emitted to the atmosphere.

2.1 Principle

This is done by simultaneously measuring the vapor mass flux through four significant areas:

$m_{(1)}$ = the mass flux through openings at the dispensing interface,

$m_{(2)}$ = the mass flux through the vapor return line,

$m_{(3)}$ = the mass flux through the dispensing facility vent, and

$m_{(4)}$ = the mass flux through the assist processor.

The percent vapor recovery efficiency is determined as follows:

$$\% \text{ vapor recovery efficiency} = \frac{m_{(2)} - [m_{(3)} + m_{(4)}]}{[m_{(2)} + m_{(1)}]} \times 100\%$$

2.2 Summary

As required to determine an emissions parameter and except where otherwise specified, the equipment and procedures specified in the following test methods shall be used.

EPA Method 2A	Direct Measurement of Gas Volume Through Pipes and Small Ducts
EPA Method 2B	Determination of Exhaust Gas Volume Flow Rate From Gasoline Vapor Incinerators
EPA Method 18	Measurements of Gaseous Organic Compound Emissions by Gas Chromatography
EPA Method 25A	Determination of Total Gaseous Organic Compound Emissions Using a Flame Ionization Detector
EPA Method 25B	Determination of Total Gaseous Organic Compound Emissions Using a Nondispersive Infrared Analyzer

3 BIASES AND INTERFERENCES

3.1 Vehicle Biases and Interferences

3.1.1 Inclusion of Vehicles in Test Procedure

A representative vehicle matrix shall be determined for the subject facility according to TP-201.2B.1

3.1.2 Exclusion of Certain Vehicle Results from Test Results

Include the following vehicles in this test procedure, but exclude results for such vehicles from any determinations of compliance with or violation of the certification criterion. Report results for such vehicles separately, with a description of the likely causes for their failing to meet any requirements specified below.

For the purpose of determinations of compliance with or violation of the certification criterion, exclude vehicles with:

(1) **non-conformance with other applicable requirements,**

results for vehicles with fillpipe access zones which do not conform with applicable specifications and requirements (vehicles shall arrive at the facility with properly positioned fillpipe caps and leaded fuel restrictors appropriate for each vehicle);

(2) **non-conformance with vehicle leak check requirement,**

> **Note:** This vehicle leak check requirement may be waived, on a vehicle-by-vehicle basis, upon determination by the ARB Executive Officer that the vehicle matrix required by TP-201.2A can not otherwise be filled.
>
> This vehicle leak check requirement may be waived, on a system-by-system basis, upon determination by the ARB Executive Officer that the system is expected to always maintain negative gauge pressure in all vehicle tanks during all dispensing episodes.

results for vehicles which do not pass the vehicle leak check requirement (>0.01 cfm); and

(3) **non-conformance with sleeve leak check requirement, and**

results for vehicles with leak detector readings (per EPA Method 21) above 0.1% LEL within one inch (2.5 cm) outside the sampling sleeve; and

(4) inadequate dispensed volume.

results for vehicles into which less than four gallons are dispensed.

3.2 Facility Biases and Interferences

3.2.1 Static Pressure Performance

The subject dispensing facility shall demonstrate compliance with the appropriate static pressure performance standard as required by CP-201.

3.2.2 Representative Facility Operating Matrix

The subject facility shall operate within the matrix of conditions established in the specifications of certification. See CP-201 § 3 and § 5.

During certification testing, any conditions of installation, operation, and maintenance which deviate from such specifications, shall be recorded and included as amendments to the specifications of certification. Subsequent to such certification, any conditions which occur outside such specifications (for any facility installed, operating, and maintained on the basis of such certification) shall constitute a violation of the specifications of certification.

3.2.3 Dispensed Liquid Characteristics

Some unusual situations may require a more extended calibration protocol if, in a certain case, the speciation of vapors is significantly different than that for gasoline vapors. Two alternative approaches, both of which must be demonstrated in practice and approved as modifications to this procedure are suggested:

(1) calibrate all analyzers to appropriate dilutions of a Tedlar® bag sample taken from the headspace of the facility involved in the proposed test, or

(2) use the same make and model of analyzer at each test point while minimizing the amount of vapor taken from the vapor return line. At the vapor return line test point, this may require a high flow (to reduce time lag) sample extraction and return loop and a low flow (to satisfy analyzer requirements) sample line from the sample loop to the analyzer.

3.3 Equipment Biases and Interferences

Alternatives to the required equipment can be as good or better in certain testing circumstances. Such alternatives shall only be used subject to prior written approval by the ARB Executive Officer, as required in § 13.

A primary example of such an alternative is the use of NDIR instead of FID at Test Point 1 for analyzing the sleeve sample. There NDIR can be used based on

data and documentation which show, to the satisfaction of the ARB Executive Officer, satisfactory control of biases and interferences due to the use of the equipment.

4 SENSITIVITY, RANGE, AND PRECISION

The measurements of concentration and volumetric parameters required by this test procedure are well within the limits of sensitivity, range, and precision of the specified equipment.

5 EQUIPMENT

Equipment specifications are given below and some equipment configurations are shown in Figures 1 through 21.

5 (1) Hydrocarbon Analyzer

The default mode of determining hydrocarbon concentrations in this procedure is a determination of total hydrocarbon concentration as propane. Alternative test procedures for determining non-methane hydrocarbon concentration have been validated for some applications and may be used, subject to the approval of the ARB Executive Officer. Such procedures typically determine both the total hydrocarbon concentration and methane concentration; non-methane hydrocarbon concentration is then determined as the difference.

The range of any hydrocarbon analyzer shall be selected such that the maximum concentration measured is no more than 90 percent of the range and the average concentration is no less than 10 percent of the range.

Any sampling and analysis system using a non-dispersive infrared detector (NDIR) shall be designed so that 100% of the sample that is extracted for analysis can be returned, unaltered, to the sample manifold.

An analyzer with a NDIR with selected filters to block methane measurement shall be used when the efficiency is to be calculated for non-methane hydrocarbon and when the system under test is small such that extracting a sample for a FID analyzer will affect the system operating parameters. When using a NDIR instrument for total hydrocarbon measurements, a second channel must be present to measure the methane concentration or the instrument filters must be such that total hydrocarbon is measured.

Any sampling and analysis system using a flame ionization detector (FID) can not be designed so that 100% of the sample that is extracted for analysis can be returned, unaltered, to the sample manifold, because the operation of the FID significantly alters the portion of the sample which is analyzed.

An analyzer with a FID may be used for the test when a measurement is for total hydrocarbon and there is no requirement for returning sample, unaltered, to the sample manifold. An important example is the total hydrocarbon measurement on the diluted sample from a test sleeve which has captured

transfer emissions from the nozzle fillpipe interface. In this case, the transfer emissions are on their way to the atmosphere normally, so there is no need to return them to a sample manifold.

5 (2) **Carbon Monoxide Analyzer**

Use a NDIR analyzer for measurement of exhaust CO concentrations. To the extent practical, the analyzer range shall be selected such that the maximum concentration measured is no more than 90 percent of the range and the average concentration is no less than 10 percent of the range.

5 (3) **Carbon Dioxide Analyzer**

Use a NDIR analyzer for measurement of exhaust CO_2 concentrations. The analyzer range shall be selected such that the maximum concentration measured is no more than 90 percent of the range and the average concentration is no less than 10 percent of the range.

5 (4) **Volume**

Use a calibrated positive displacement gas volume meter or a turbine meter for measurement of volumetric flow rate.

Use rotary type positive displacement meter(s) with a back pressure limit (BPL) less than:

1.10 inches water column at a flowrate of 3,000 CFH down to 0.05 inches water column at a flowrate of 30 CFH for a meter with a rating over 1000 CFH and

0.70 inches water column at a flowrate of 800 CFH down to 0.04 inches water column at a flowrate of 16 CFH for a meter with a rating of or under 1000 CFH.

Meter(s) shall be equipped with taps accommodating the following equipment:

(1) taps on the inlet side for

(a) a thermocouple with a range of 0 to 150 °F and

(b) a pressure gauge with a range providing absolute pressure readings within 10 to 90% of the range (more than one gauge shall be used, if necessary) and

(2) taps on the inlet and outlet sides for a differential pressure gauge with a range of 0 to < 2x BPL (i.e. full scale shall be less than twice the back pressure limit) or any other range appropriate to allow detection of a pressure drop greater than the BPL.

5 (5) **Pressure**

Use a pressure measuring device (transducer, inclined manometer or Magnahelic gauge) with a design range suitable for the pressure being measured. The tap for the pressure measurement shall be located on the sample coupling attached to the inlet of the volume meter.

5 (6) **Temperature**

Use a temperature measuring device (thermocouple or mercury in glass thermometer) with a design range suitable for the temperature being measured. The tap for the temperature measurement shall be located on the sample coupling attached to the inlet of the volume meter.

5.1 Equipment for Test Point 1 (Nozzle Sleeve)

5.1.1 Vehicle Leak Check Equipment

The following equipment is necessary to perform required vehicle leak checks; or to demonstrate that alternative equipment will perform equivalently (see "ALTERNATIVE TEST PROCEDURES" section).

5.1.1.1 Fillpipe Interface

A fillpipe interface shall be used which provides a seal at the fillpipe outlet except for:

(1) tubing for pressurizing the fillpipe and vehicle tank with nitrogen and

(2) tubing for connection to a pressure transducer which can register the pressure in the fillpipe and vehicle tank.

5.1.1.2 Flowmeter and Pressure Transducer

A flowmeter and pressure transducer shall be used which are appropriately sized for measuring 0.01 cfm and one-half (0.5) inches water (gauge) at the fillpipe interface.

5.1.1.3 Pressure System

The pressure system for the vehicle leak check shall consist of a nitrogen bottle (2000 psig, commercial grade), a control valve for regulating the bottle pressure to 1 psig, a needle valve, two Magnahelic gauges (0 - 30 and 0 - 10 inches water) for determining the pressure upstream and downstream of the needle valve, and a hose for supplying pressure to the vehicle tank. The pressure system shall provide for monitoring the pressure in the fillpipe and vehicle tank during the vehicle leak check.

5.1.2 **Sleeve Leak Check Equipment**

A volatile organic compound detector which complies with the requirements of EPA Method 21 shall be used.

5.1.3 **Implements**

5.1.3.1 **Sleeve**

The sleeve is designed for vapor sampling at the dispensing area. An example design for the sleeve is shown in Figures 6 through 8.

Other designs may be used which accommodate different dispensing area geometries, subject to the requirement that other designs yield no more pressure drop at five cubic feet per minute (cfm) air flow than the design shown. Compliance with this requirement must be documented in the test report required in the section, "REPORTING RESULTS".

The design shown has been tested, at 5 cfm with -0.005 "WC gauge pressure inside the sleeve, during use in a balance nozzle application. The comparison standard may differ in other dispensing geometries.

5.1.3.2 **Sleeve Sample Tubing**

The sample tube connecting the sleeve to its instrumentation shall be as flexible and lightweight as practical so that the behavior of the nozzle operator is minimally affected by testing activities. It is not necessary to return the unanalyzed portion of sample flow back to the GDF vapor recovery system.

In general, only a portion of the sleeve flow is used for analysis. Most analyzers sample at a flow rate far below the 5 cfm sleeve flow rate. In such a case, sleeve sample tubing must be configured so that a portion of the sleeve flow is representatively sampled by the analyzer at conditions suitable for the analyzer requirements.

5.1.3.3 **Sleeve Sample Pump**

> **Note:** The sample flow rate must always be high enough to prevent the sleeve leak check from registering more than 0.1% LEL (2,100 ppm as propane).

Use a carbon vane (or equivalently non-contaminating) pump to minimize contamination of the sample.

The pump must be capable of pulling about 5 cfm, but lower flow rates are acceptable subject to the following requirement:

The pressure drop is typically a few inches Hg, depending on tubing and fittings.

5.1.4 Instruments

5.1.4.1 Hydrocarbon Concentration

Use an FID with full scale values of 1.00% and 10.0%. Perform span and calibration checks with propane standards.

5.1.4.2 Volume (See § 5.4)

5.1.4.3 Pressure

Use a pressure measuring device (transducer, inclined manometer or Magnahelic gauge) with a design range suitable for the pressure being measured. The tap for the pressure measurement shall be located on the sample coupling attached to the inlet of the volume meter.

5.1.4.4 Temperature

A transducer with an initial design range of 0 - 150°F in a thermocouple design, depending on the sleeve tubing chosen. The tap must be near the HC instrument inlet.

5.2 Equipment for Test Point 2 (Vapor Return)

5.2.1 Implements

5.2.1.1 In-line Plumbing

Design goals for plumbing arrangements, regardless of GDF, are:

(1) practically minimize length of vapor return line between the nozzle and the sample point for Test Point 2; do this to minimize problems related to entry of condensation from the vapor return line into the Test Point 2 sample line;

(2) practically minimize pressure drop across in-line plumbing; and

(3) return any unanalyzed sample to the GDF vapor return line.

5.2.1.2 Fittings

Plumbing shall be designed for easy adaptability to co-axial, twin hose, and any other GDF configurations which may be encountered. A one inch (i.d.) ball valve shall isolate the vapor return line from other implements.

5.2.2 Instruments

5.2.2.1 Hydrocarbon Concentration

Use a NDIR with a full scale value of 100.0%, or a lower value which is known to be above the maximum concentration possible at test

conditions. Perform span and calibration checks with appropriate propane standards.

5.2.2.2 Volume (See § 5.4)

5.2.2.3 Pressure

Use a pressure measuring device (transducer, inclined manometer or Magnahelic gauge) with a design range suitable for the pressure being measured. The tap for the pressure measurement shall be located on the sample coupling attached to the inlet of the volume meter.

5.2.2.4 Temperature

Use a transducer with an initial design range of 0 - 150°F in a thermocouple design.

5.3 Equipment for Test Point 3 (Vent)

5.3.1 Implements

Unanalyzed sample shall be returned to the system to avoid perturbation of the system pressure.

5.3.2 Instruments

5.3.2.1 Hydrocarbon Concentration

Upstream from any final point of release to the atmosphere, use a NDIR with a full scale value of 100.0%, or a lower value which is known to be above the maximum concentration possible at test conditions. Perform span and calibration checks with appropriate propane standards.

Sample may be collected downstream of the normal point of release to the atmosphere in situations where upstream techniques are precluded. Some special sealed sleeve or other means of gathering and delivering sample to the analyzer must be employed; before testing commences, any such sleeve or means must pass the leak check criteria given in the procedures provided for leak checking the nozzle sleeve. Tape and polyethylene bags have been used to successfully meet this requirement.

5.3.2.2 Volume (See § 5.4)

5.3.2.3 Pressure

Use a pressure measuring device (transducer, inclined manometer or Magnahelic gauge) with a design range suitable for the pressure being measured. The tap for the pressure measurement shall be located on the sample coupling attached to the inlet of the volume meter.

5.3.2.4 Temperature

Use a transducer with an initial design range of 0 - 150°F in a thermocouple design.

5.4 Equipment for Test Point 4 (Assist Processor Exhaust)

See section, "ALTERNATIVE TEST PROCEDURES" if equipment specified above is not applicable.

6 CALIBRATION PROCEDURE

A record of all calibrations shall be maintained.

6.1 Analyzers

Follow the manufacturer's instructions concerning warm-up time and adjustments. On each test day prior to testing, zero the analyzer with a zero gas and span with a known concentration of calibration gas at a level near the highest concentration expected. Perform an intermediate zero and span calibration approximately 2 hours after the initial calibration and at any time a calibration drift is evident. Check for zero and span calibration drift at the end of the test period. All calibrations and adjustments shall be documented.

6.2 Volume Meters

Meters shall be calibrated on an annual basis.

6.3 Pressure Transducers

Calibrate pressure transducers prior to testing and immediately following the test period with a static pressure calibrator for a range of -3 to +3 inches water or appropriate range of operation; or calibrate pressure transducers in accordance with manufacturer's specifications and provide a copy of such specifications in the Certification Test Report.

6.4 Temperature Transducers

Calibrate temperature transducers every six months using ambient air, the temperature of which is determined by a NIST traceable mercury-glass thermometer.

7 PRE-TEST PROTOCOL

7.1 Location of Test Site

Prototype systems will be located within 100 miles of Sacramento for testing. Other locations may be accepted at the discretion of the ARB Executive Officer.

7.2 Specification of Test, Challenge, and Failure Modes

The specification of test, challenge, and failure modes such as the number of liquid transfer episodes, volume and volumetric rate of liquid transfer, storage tank volumes, etc. shall be done according to the principles of CP-201 § 5 for the testing and evaluation of vapor recovery equipment.

7.3 System and Facility Preparation

The required preliminary evaluation shall set the final requirements for facility preparation. The dominant principle shall be that testing activities minimally alter facility and system conditions. As the installation of test equipment can alter facility and system values for critical parameters, the following final preparation procedures shall be applied, subject to determination by the ARB Executive Officer of more effective alternatives for some procedures and the only practical alternatives for other procedures:

(1) Install all equipment and wait at least 16 hours before testing. Until then, provide conditions which minimally disturb facility and system operations due to the presence of such equipment for such time; or

> **Warning:** the following alternative shall only be used after a determination, per the preliminary evaluation, that system pressure is the only system parameter disturbed by equipment installation and that volumetric flow from the system can be monitored by procedures which minimally disturb facility and system operations.

(2) install all equipment and wait until a determination of a flow of 0.1 ACF from the system before testing. Until then, provide conditions which minimally disturb facility and system operations due to the presence of such equipment for such time.

7.4 Testing Sequence

> **Note:**
>
> For the applicant, this test procedure is the most costly required test procedure. As the applicant's candidate system must pass all required tests, costs for the applicant can be minimized by performing all other procedures before the "100 car" test specified in this procedure and TP-201.2A. In this way, if the system fails one of the less costly tests, required redesign and refabrication of the system can proceed at the least cost.

The testing sequence shall be as follows:

7.4.1 Other Required Test Procedures

All other required test procedures shall be performed before the application of TP-201.2A for the 100 car test specified in this procedure.

7.4.2 **Other Required Aspects of this Test Procedure**

All other required aspects of this test procedure shall be performed before the application of TP-201.2A for the 100 car test specified in this procedure, e.g. testing idle nozzle episodes.

8 TEST PROCEDURE

The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

In this section, the term "vent" and the specified procedures for testing vents shall also apply to any assist processor with which such procedures are compatible. Procedures are also specified for incinerator type assist processors. Any assist processor which is incompatible with the application of these procedures shall not be certified until the compatibility requirements of the certification procedures are met.

8.1 Test Locations

Figure 1 illustrates mass flux test locations.

8.1.1 Test Point 1 (Nozzle Sleeve)

Figure 2 emphasizes the mass flux test location for Test Point 1 (Nozzle Sleeve).

8.1.1.1 Vehicle Leak Check Procedure

Three different procedures are acceptable for checking leaks in vehicle tanks and plumbing.

(1) **Nitrogen Pressurization**

Figure 3 illustrates the following procedure, which is necessary to perform required vehicle leak checks; or to demonstrate that an alternative procedure will perform equivalently (see "ALTERNATIVE TEST PROCEDURES" section).

(a) Connect equipment for vehicle leak check to vehicle fillpipe.

(b) Open main valve on the nitrogen supply bottle and adjust the needle valve until the pressure in the fillpipe reaches one-half (0.5) inches water (gauge). If such pressure can not be maintained for 15 seconds, record an unacceptable vehicle leak for the subject vehicle.

(c) Determine the leak rate by either timing a volume of 0.1 ft^3 or by observing for 15 seconds, whichever results in a smaller volume being transferred to the vehicle tank. Record readings.

(d) Disconnect equipment from the vehicle fillpipe and proceed with further test procedures.

(e) If a leak-rate greater than 0.01 cfm, record an unacceptable vehicle leak for the subject vehicle.

(2) Manual Compression

Figure 4 illustrates the following procedure.

(a) Use a vapor tight, sealed, compressible device with an attached pressure gauge and seal the device against the vehicle fill pipe interface.

(b) Compress the device in a repeatable and controlled manner and record readings from the pressure gauge.

(c) Determine vehicle leak check status by comparing pressure readings with a calibration chart which must be developed independently, for each compression device and tester, as specified below:

(i) Perform the specified vehicle leak check procedure and the alternative compression procedure on a series of vehicles.

(ii) Correlate the readings from the specified vehicle leak check procedure and the alternative compression procedure which relate to passing and failing the vehicle leak check requirement. Include all significant variables in the correlation.

(iii) Construct a calibration chart from the correlations in (ii), indicating those readings from the alternative compression procedure which correlate with passing and failing the vehicle leak check requirement.

(3) Manual De-compression

Figure 5 illustrates the following procedure.

(a) Prepare to listen for a sound of vapor de-compression from the vehicle tank and fillpipe, before removing a vehicle fillpipe cap.

(b) Remove the cap in a quick, repeatable, and controlled manner and listen for a sound of vapor de-compression from the vehicle tank and fillpipe. Record a positive or negative reading of the occurrence of such sound when the cap is removed.

(c) Determine vehicle leak check status by comparing positive readings with a calibration chart which must be developed independently, for each de-compression tester, as specified below:

(i) Perform the specified vehicle leak check procedure and the alternative de-compression procedure on a series of vehicles.

(ii) Correlate the readings from the specified vehicle leak check procedure and the alternative de-compression procedure which relate to passing and failing the vehicle leak check requirement. Include all significant variables in the correlation.

(iii) Construct a calibration chart from the correlations in (ii), indicating those readings from the alternative de-compression procedure which correlate with passing and failing the vehicle leak check requirement.

8.1.1.2 **Nozzle Sleeve Assembly**

The sleeve must be sampling around all potential vapor leak paths at all times during testing including:

dispensing periods; and

"idle nozzle" periods

as explained below, after a description of the sleeve leak check procedure.

(1) **Sectional View of Sleeve**

Figure 6 illustrates a sectional view of a nozzle sleeve.

(2) **Axial View of Sleeve**

Figure 7 illustrates an axial view of a nozzle sleeve.

(3) **View of Sleeve on Nozzle**

Figure 8 illustrates a view of a nozzle sleeve on a nozzle.

The sleeve must be sampling around all potential vapor leak paths at all times during testing including:

(a) dispensing periods; and

(b) "idle nozzle" periods

as explained below, after a description of the sleeve leak check procedure.

8.1.1.3 Leak Check of Sleeve

At least once during each dispensing period and once during "hang time" (as soon as practical after nozzle "hang-up"), readings must be taken with a leak detector per EPA Method 21. If possible, adjust the sleeve so that readings are below 0.1% LEL (2,100 ppm as propane) during within one inch (2.5 cm) outside the sampling sleeve.

(1) View of Combustible Gas Detector

Figure 9 illustrates a view of a combustible gas detector.

(2) View of Combustible Gas Detector in Use

Figure 10 illustrates a view of a combustible gas detector in use.

8.1.1.4 Nozzle Sleeve Measurements

The sleeve temperature and pressure measurements must be taken from a sample manifold attached to the inlet of the volume meter on the sleeve sampling system. The hydrocarbon sample shall be taken at the exhaust side of the volume meter.

In the interest of reducing the amount of chart paper to be recorded and read and reducing the wear on pumps, and at the discretion of the ARB Executive Officer, the chart drive and pumps may be turned off whenever the sleeve sample concentration drops below 100 ppm. If this option is exercised by the test team, they must stand ready to resume operation of all sampling equipment immediately after the sample concentration climbs above 100 ppm. Also, the start and stop times for such periods during which the chart drive is off must be clearly marked on the chart record. See "ALTERNATIVE TEST PROCEDURES" section.

(1) Volume Measurement

Figure 11 illustrates equipment for volume measurements of samples from the nozzle sleeve.

(2) Concentration Measurement

Figure 12 illustrates equipment for concentration measurements of samples from the nozzle sleeve.

8.1.1.4.1 Dispensing Episodes

The tester begins data collection for a dispensing episode with the insertion of the nozzle into the vehicle and continues until

the end of the "response time" which is defined per EPA Method 21 as follows:

Introduce zero gas into the sleeve until the analyzer reading has stabilized, then switch quickly to the specified calibration gas (§ 6.1). Measure the time interval from switching to attainment of 90% of the final stable analyzer reading. Perform this test sequence three times, calculate the average, and define the result as the "response time."

The nozzle user is to dispense normally and terminate dispensing in the user's customary manner. The tester shall also instruct the user that upon deciding that termination is complete, the nozzle user shall so declare for the tester to hear.

To achieve this, and prior to nozzle insertion and for every dispensing episode, the tester shall provide simple, clear instructions to the nozzle user. The instructions shall be the same for each nozzle user.

After hearing that the user has terminated dispensing, the tester waits for the response time and then ends data collection for the dispensing episode.

The sleeve must always be at the fillpipe/nozzle interface for sample collection during any dispensing episode.

Sample at a nominal flow rate of 5 cfm, or less subject to the requirement that the sleeve leak check is less than 0.1% LEL (2,100 ppm as propane).

8.1.1.4.2 **Idle Nozzle Episodes**

An idle nozzle episode is any time other than a dispensing episode.

In the interest of improving the accuracy of idle nozzle data and reducing the wear on pumps, and at the discretion of the ARB Executive Officer, idle nozzle data may be taken from vehicles other than those in the required vehicle matrix for efficiency testing. Accuracy can be improved and pump wear reduced by avoiding the need to frequently change sample pump speed (to change from one dilution for the higher concentration dispensing sample to another dilution for the lower concentration idle nozzle sample). This option shall only be allowed if an adequately representative sample of vehicles is used for idle nozzle sampling. See "ALTERNATIVE TEST PROCEDURES" section.

Because idle nozzle emissions do not involve the nozzle/fillpipe interface, the determination of a vehicle matrix per TP-201.2A is not necessary.

(1) Idle Nozzle Screening Test Procedure

(a) Follow the instructions for the Leak Check of the Sleeve, but use the leak detector to determine if the nozzle is "leaking" idle nozzle emissions.

(i) Non-compliance is indicated by a reading at or above 2,100 ppm as propane (0.1% LEL).

(ii) Compliance is indicated when the procedures of EPA Method 21 have been followed and all readings are below 2,100 ppm as propane (0.1% LEL).

(b) Collect such data for up to twenty-five (25) idle nozzle episodes.

(i) If a non-complying episode occurs, proceed to the Idle Nozzle Sleeve Test Procedure below.

(ii) If only complying episodes occur for the first twenty-five (25) idle nozzle episodes, record a determination of compliance with the idle nozzle test requirement; indicate in the Certification Report that idle nozzle emissions were not detected.

(2) Idle Nozzle Sleeve Test Procedure

(a) Empirically determine, record, and employ a sample pump flow rate and analyzer range appropriate for any detectable idle nozzle emissions from the system.

(b) Using the procedures and calculations for Test Point 1, prepare to collect data in order to calculate results in units of pounds of hydrocarbon emitted per thousand gallons of fuel dispensed.

(3) Collect such data for twenty-five (25) idle nozzle episodes.

(a) If the overall result, in units of pounds of hydrocarbon emitted per thousand gallons of fuel dispensed, for all mass emitted divided by all fuel dispensed is over 0.42 pounds per thousand gallons (0.42 #/E3G), disapprove the application per CP-201 §2.2; the applicant must re-apply for

further consideration of the system except as (4) below is applied.

(b) If the overall result is at or under 0.42 #/E3G, record the result for further calculations and proceed with the remainder of the required tests.

(4) At the applicants option, collect such data for seventy-five (75) more idle nozzle episodes; follow the instructions provided in step (3) (a) to obtain the overall result for all one hundred (100) data sets.

(a) If the overall result, in units of pounds of hydrocarbon emitted per thousand gallons of fuel dispensed, for all mass emitted divided by all fuel dispensed is over 0.42 pounds per thousand gallons (0.42 #/E3G), disapprove the application per CP-201 §2.2; the applicant must re-apply for further consideration of the system.

(b) If the overall result is at or under 0.42 #/E3G, record the result for further calculations and proceed with the remainder of the required tests.

8.1.2 **Test Point 2 (Vapor Return)**

Figure 13 emphasizes mass flux test locations for Test Point 2 (Vapor Return Line).

The vapor return line sample and temperature and pressure measurements must be taken from a sample manifold attached to the inlet of the volume meter which has been inserted at a break in the vapor return line. The break is usually at the vapor hose connection to the vapor riser from under the pavement. When options are available, the sampling location shall be the shortest practical downstream distance from the nozzle to minimize vapor condensation upstream of the sampling location. Unaltered sample shall be returned to the sample manifold.

8.1.2.1 **Volume Measurement, General**

Figure 14 generally illustrates equipment for volume measurements of samples from the vapor return line.

8.1.2.2 **Volume Measurement, Single Vapor Return Line**

Figure 15 specifically illustrates metering equipment for volume measurements of samples from a single vapor return line.

8.1.2.3 **Volume Measurement, Manifolded Vapor Return Lines**

Figure 16 specifically illustrates metering equipment for volume measurements of samples from the vapor return line.

8.1.2.4 **Concentration Measurement**

Figure 17 illustrates equipment for concentration measurements of samples from manifolded vapor return lines.

8.1.3 **Test Point 3 (Vent and/or Assist Processor)**

Figure 18 emphasizes mass flux test locations for Test Point 3 (Vent and/or Assist Processor).

Test point 3 shall always be at the outlet from the vent riser. The operation of test equipment shall not interfere with the normal operation of any valve or vent.

8.1.3.1 **Single Vent Volume Measurement**

Figure 19 illustrates equipment for volume measurements of samples from a single vent at Test Point 3.

8.1.3.2 **Manifolded Vents Volume Measurement**

Figure 20 specifically illustrates metering equipment for volume measurements of samples from manifolded vents at Test Point 3 .

8.1.3.3 **Vent or Vents Concentration Measurement**

Figure 21 illustrates equipment for concentration measurements of samples from a vent or vents.

8.1.4 **Test Point 4 (Vapor Incinerator)**

8.1.4.1 **Incinerator Performance Specifications**

Incinerator emissions shall be determined using the procedures of EPA M-2B, as outlined in this procedure, including any additional requirements provided below.

Any incinerator shall be evaluated and tested to establish:

(1) a performance specification for carbon monoxide (CO) emissions and

(2) performance specifications for other critical incinerator operating parameters per CP-201 § 3 which requires, in part:

The results of evaluation and testing of the system, documented in the certification test report, shall include:

(1) the identification of such critical system operating parameters,

(2) the performance specifications for such critical system operating parameters, and

(3) the specification of requirements for indicating gauges, detection devices, and alarms.

Challenge and failure mode testing shall be performed to establish system sensitivity to and performance specifications for the following variables:

(1) storage tank ullage at start of liquid transfer

(2) volume and volumetric rate of liquid transfer

(3) number of nozzles in simultaneous use and

(4) individual nozzle dispensing rates.

Compliance with the incinerator performance specifications shall be determined per CP-201, as applicable.

8.1.4.2 **Incinerator Sampling Parameters**

A preliminary evaluation of incinerator operation shall be conducted to determine data collection intervals for time and parameter magnitude for each parameter. Such intervals shall be chosen to provide calculated estimates of incinerator mass emissions factors which differ by no more than ± 10% from actual, based on engineering judgment.

Data for each parameter shall be collected on such intervals.

Collect and record incinerator data for all of the parameters required to make a determination per EPA M-2B, with additional requirements for auxiliary fuel to expand the applicability of EPA M-2B:

V_{in} = total inlet volume entering vapor incinerator (SCF)

$V_{facility}$ = inlet volume from the facility vapor space (SCF)

V_{fuel} = inlet volume of auxiliary fuel (SCF)

V_{out} = vapor incinerator outlet volume (SCF)

N = number of carbon atoms in each molecule of calibration gas

$[HC]_{facility}$ = hydrocarbon concentration of inlet volume from the facility vapor space (volume fraction)

$[HC]_{fuel}$ = hydrocarbon concentration of auxiliary fuel (volume fraction)

$[HC]_{out}$ = vapor incinerator outlet hydrocarbon concentration (ppm)

$[CO_2]$ = vapor incinerator outlet carbon dioxide concentration (ppm)

[CO] = vapor incinerator outlet carbon monoxide concentration (ppm)

Based on an engineering evaluation of a subject incinerator, the ARB Executive Officer may allow simplifying assumptions to be used in place of actual data collection. For example, for auxiliary fuel, it is often possible to use data from the fuel supplier.

8.1.4.3 **Incinerator Visual Inspection**

Visual Inspection. Any visible emissions except for steam, from vapor incinerators are an indication of poor combustion. An incinerator shall not emit air contaminants (not including moisture) in such a manner that the opacity of the emission is greater than 10 percent for a period or periods aggregating more than one minute in any 60 consecutive minutes; or greater than 40 percent opacity at any time. Should such visible emissions from the exhaust be detected, the control system is unacceptable and the problem must be corrected and an application made to the ARB Executive Officer for reconsideration for certification.

8.1.4.4 **Incinerator Exhaust Sample Location**

The vapor incinerator exhaust sample must be taken from the exhaust stack down-stream of the burner far enough to permit complete mixing of the combustion gases. For most sources, this point is at least eight stack diameters downstream of any interference and two diameters upstream of the stack exit. There are many cases where these conditions cannot be met. The sample point shall be no less than one stack diameter from the stack exit and one stack diameter above the high point of the flame and be at a point of maximum velocity head. Vapor incinerator emissions shall be monitored for a 24 hour period beginning at the time of the first dispensing period.

8.1.4.5 **Incinerator Inlet Sample Location**

The vapor incinerator inlet sample and temperature and pressure measurements must be taken from a sample manifold attached to the inlet side of the volume meter which has been inserted at a break in the inlet line. The installation of test equipment shall not interfere with the normal operation of the vapor incinerator. Unaltered sample shall be returned to the sample manifold.

8.2 General Sampling Parameters

The test team shall collect and record frequent periodic or continuous measurements of the following sample gas variables shown in hexagon outlines in Figure 1:

HC = Hydrocarbon Concentration

CO = Carbon Monoxide Concentration

CO_2 = Carbon Dioxide Concentration

V = Volume

P = Pressure

T = Temperature

8.3 Other Sampling Parameters

Test Point 1 (Nozzle Sleeve)

Dispensed Fuel Vapor Pressure

Dispensed Fuel Volume

Test Point 2 (Vapor Return)

Dynamic Back-Pressure as Found

Test Point 3 (Vent or Vapor Processor)

Valve Cracking Pressure

Phase I Delivery Descriptions

Test Point 4 (Vapor Incinerator)

Design Operating Parameters

Actual Operating Parameters

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

9.1 Analyzers

Perform a comprehensive calibration in the laboratory every six months. Check the analyzer with several known concentrations of calibration from reference cylinders to determine linearity.

9.2 Calibration Gases

Calibration gases are classified into three types:

(1) Standard Reference Materials

These are primary standards to which all other standards shall be traceable. For any substance for which no standard reference material is obtainable, a calibration gas of the highest level of accuracy and precision obtainable shall qualify as a standard reference material, subject to approval by the ARB Executive Officer.

A standard reference material, which normally is kept at a main laboratory, qualifies as an intermediate standard and as a working standard, too.

(2) Intermediate Standards

These are secondary standards which shall be assayed versus the corresponding NIST-SRM once every six months with a concentration difference which is no more than one percent of the results for the NIST-SRM. An intermediate standard container which does not meet its assay requirement shall be taken out of service. To re-enter service, the intermediate standard container shall be recharged and meet its assay requirement.

An intermediate standard, which normally is kept at a branch laboratory or a shop, qualifies as a working standard, too.

(3) Working Standards

These are tertiary standards which shall be assayed versus the corresponding intermediate standard before every test with a concentration difference which is no more than one percent of the results for the intermediate standard. A working standard container which does not meet its assay requirement shall be taken out of service. To re-enter service, the working standard container shall be recharged and meet its assay requirement.

A working standard normally serves for field calibration and testing.

A "Certificate of Analysis" from the gas supplier can be submitted in the Certification Test Report as evidence of compliance with the specifications above; regardless of such certificate, the tester is ultimately responsible for satisfying the requirements given above in the event that a certificate is contradicted by subsequent analysis of the contents of a certified gas container.

All calibrations shall be performed with a calibration gas of at least working standard quality. Any cylinder is to be recharged or taken out of service when the cylinder pressure drops to 10 percent of the original pressure.

Information on calibration gas containers shall be entered into a permanent log identifying each container by serial number. Sufficient information shall be maintained to allow a determination of the compliance status of each calibration gas per these requirements; such information shall include for each container, but not be limited to each:

(1) date put in service,

(2) assay result, and

(3) date taken out of service.

9.3 Volume Meters

Standard methods and equipment shall be used to calibrate the meters on an annual basis. The calibration curves are to be traceable to NIST standards.

10 RECORDING DATA

(1) **Chain of Custody**

Written data records must be kept during testing and kept by chain of custody.

(2) **Necessary and Sufficient Data**

Written data records must contain all information used to calculate and report final results.

(3) **Reconciliation of Reported Results to Recorded Data**

The final results must be verifiable by recalculation from the written data records.

(4) **Permanent Records**

These written data records must be kept permanently filed and available for use by the Executive Officer of the Air Resources Board when requested.

11 CALCULATING RESULTS

> Note: In addition to other required calculations, vapor recovery system test results shall be calculated in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

Calculate all efficiency results to the nearest 0.1%.

11.1 General Nomenclature

Figure 1 illustrates some parameters specified in the calculations.

11.1.1 Parameters

General parameters are listed below, other parameters are defined in the calculations or alternative procedures:

[HC] = hydrocarbon concentration (volume fraction),

V_m = measured volume of gases and vapors,

P = pressure, and

T = temperature.

For any dispensing episode:

D = volume of liquid dispensed, and

Δt = elapsed time of dispensing.

11.1.2 Subscripts

Subscripts shall be used to distinguish parameters and modes of measurement, e.g.:

$P_{(s,e,t)}$ = value of parameter "P" for subinterval "s" of dispensing episode "e" at test point "t".

Any or all of these subscripts may modify a parameter, and for consistency, subscripts will appear in the order given above, e.g.:

$P_{(e,t)}$ = value of parameter "P" for dispensing episode "e" at test point "t"; and

P_t = value of parameter "P" for an entire test at test point "t".

11.2 Standardization and Calibration of Parameters

11.2.1 Volume Standardization

Directly measured volumes (such as those directly measured for Test Points 1, 2, and 3) shall be standardized as follows:

$$V = V_m \left(\frac{528}{T}\right) \left[\frac{P_b + \left(\frac{P}{13.6}\right)}{29.92}\right]$$

where:

V = volume corrected to standard conditions (ft^3).

V_m = measured volume (ft^3).

P_b = barometric pressure (in. Hg).

P = differential pressure in sample line (in. water gauge).

T = temperature of gas stream (°R).

11.2.2 Concentration

Each measured concentration of gas and vapor shall be corrected for any analyzer zero and/or span drifts and shall be expressed as a volume fraction (i.e. % or ppm).

11.2.3 Mass

Masses shall be calculated from calibration data and measurements as follows:

$$m = \left(\frac{MW}{385}\right) \times [HC] \times V$$

where:

m = mass (lb)

MW = molecular weight of calibration gas (lb/lb-mole)

385 = standard volume of one lb-mole at 528°R and 29.92 in. Hg

Note for manual data reduction: In general, $[HC]_{(e,t)}$ will stabilize to a steady value during a dispensing interval. If this is not the case, break $V_{(e,t)}$ into "s" subintervals and calculate:

$$m_{(e,t)} = \left(\frac{MW}{385}\right) \times \sum_{1}^{s} \left([HC]_{(s,e,t)} \times V_{(s,e,t)}\right)$$

11.3 Volume Calculations

11.3.1 Volume for Test Point 1 (Nozzle Sleeve)

This volume is directly measured and shall be standardized per § 11.2.1.

11.3.2 Volume for Test Point 2 (Vapor Return Line)

This volume is directly measured and shall be standardized per § 11.2.1.

11.3.3 Volume for Test Point 3 (Vent and/or Assist Processor)

This volume is directly measured and shall be standardized per § 11.2.1.

11.3.4 Volume for Test Point 4 (Incinerator)

Note the possibility for simplifying assumptions described in § 8.1.4.2.

11.3.4.1 Preliminary Incinerator Outlet Volume Calculations

Before calculating the vapor incinerator outlet volume, calculate the following preliminary values:

(1) **inlet volume from the facility vapor space**

Any inlet volume from the facility vapor space entering the vapor incinerator is directly measured and shall be standardized per § 11.2.1.

(2) **inlet volume of auxiliary fuel**

Any inlet volume from auxiliary fuel entering the vapor incinerator is directly measured and shall be standardized per § 11.2.1.

(3) **total inlet volume entering vapor incinerator**

$$V_{in} = V_{facility} + V_{fuel}$$

where:

V_{in} = total inlet volume entering vapor incinerator (SCF)

$V_{facility}$ = inlet volume from the facility vapor space (SCF)

V_{fuel} = inlet volume of auxiliary fuel (SCF)

(4) **inlet hydrocarbon concentration**

$$[HC]_{in} = \frac{(N\ [HC]_{facility}\ V_{facility}) + (N\ [HC]_{fuel}\ V_{fuel})}{V_{in}}$$

where:

$[HC]_{in}$ = inlet hydrocarbon concentration entering vapor incinerator (ppm)

N = number of carbon atoms in each molecule of calibration gas

$[HC]_{facility}$ = hydrocarbon concentration of inlet volume from the facility vapor space (volume fraction)

$[HC]_{fuel}$ = hydrocarbon concentration of auxiliary fuel (volume fraction)

11.3.4.2 Final Incinerator Outlet Volume Calculations

Calculate any vapor incinerator outlet volume using the following equation:

$$V_{out} = V_{in}\left[\frac{[HC]_{in}}{N\,[HC]_{out} + [CO_2] + [CO] - 300}\right]$$

where:

V_{out} = vapor incinerator outlet volume (SCF)

N = number of carbon atoms in each molecule of calibration gas

$[HC]_{out}$ = vapor incinerator outlet hydrocarbon concentration (ppm)

$[CO_2]$ = vapor incinerator outlet carbon dioxide concentration (ppm)

[CO] = vapor incinerator outlet carbon monoxide concentration (ppm)

300 = assumed background concentration (ppm) of CO_2

11.4 Calculations of Emissions During Idle Nozzle Episodes

To evaluate the possibility of a system eventually meeting the efficiency performance standard, these calculations must be completed before the Dispensing Facility Vent Calculations, the Individual Dispensing Episode Calculations, and the ultimate Efficiency Test Result Calculation.

Idle nozzle emissions of HC at a dispensing facility must be apportioned to each dispensing episode on a proportional basis of dispensed volume.

11.4.1 Total Idle Nozzle Emissions

Total idle nozzle emissions for all idle nozzle episodes:

m_1 = HC mass through mass flux area 1 (idle nozzle)

If the ARB Executive Officer determines that a portion of m1 is due to Phase I activity, then m1 may be diminished by that portion.

11.4.2 **Apportioned Idle Nozzle Emissions**

For any D_e:

$f(D_e,m_1)$ = the fraction of idle nozzle emissions assigned to each dispensing episode on a proportional basis of dispensed volume.

$$= \frac{(\text{liquid volume dispensed})_i}{(\text{all liquid volume dispensed during flux of } m_1)}$$

$$m_{(e,1)} = m_1 \times f(D_e,m_1)$$

11.5 **Dispensing Facility Vent Calculations**

To evaluate the possibility of a system eventually meeting the efficiency performance standard, these calculations must be completed before the Individual Dispensing Episode Calculations and the ultimate Efficiency Test Result Calculation.

Vent emissions of HC at a dispensing facility must be apportioned to each dispensing episode on a proportional basis of dispensed volume.

11.5.1 **Total Vent Emissions**

Total vent emissions for all dispensing episodes:

m_3 = HC mass through mass flux area 3 (vent)

If the ARB Executive Officer determines that a portion of m_3 is due to Phase I activity, then m_3 may be diminished by that portion.

11.5.2 **Apportioned Vent Emissions**

For any D_e:

$f(D_e,m_3)$ = the fraction of vent emissions assigned to each dispensing episode on a proportional basis of dispensed volume.

$$= \frac{(\text{liquid volume dispensed})_i}{(\text{all liquid volume dispensed during flux of } m_3)}$$

$$m_{(e,3)} = m_3 \times f(D_e,m_3)$$

11.6 Individual Dispensing Episode Calculations

Processor and incinerator emissions of HC at a dispensing facility must be apportioned to each dispensing episode on a proportional basis of dispensed volume. Use the same apportionment algorithm as for the vent emissions above.

The term "dispensing episode" is used here to generalize the applicability of these procedures.

Unless otherwise specified by the certification process, a dispensing episode starts with the removal of a nozzle from a dispenser and ends with the start of the next dispensing episode when the nozzle is removed again.

It is assumed that dispensing is into a vehicle fuel tank with a fillpipe test point and a vapor return line test point, but these calculations also apply to, for example, dispensing into surrogate tanks such as 55 gallon drums.

11.6.1 Mass through a Given Test Point

For any dispensing episode:

$m_{(e,t)}$ = HC mass through a given test point

11.6.2 Individual Dispensing Episode Calculations

Each dispensing episode efficiency, E_e, is calculated from the $m_{(e,t)}$:

$$E_e = \frac{m_{(e,2)} - [m_{(e,3)} + m_{(e,4)}]}{[m_{(e,2)} + m_{(e,1)}]} \times 100\%$$

where:

$m_{(e,1)}$ = the mass flux through openings at the dispensing interface,

$m_{(e,2)}$ = the mass flux through the vapor return line;

$m_{(e,3)}$ = the mass flux through the vent and/or the assist processor; and

$m_{(e,4)}$ = the mass flux through the vapor incinerator.

11.7 Efficiency Test Result Calculation

For the tested vapor recovery equipment, the efficiency test result, E, for this procedure is:

$$E = \sum_{1}^{n} \left[\frac{E_e}{n} \right]$$

where "n" is the number of dispensing episodes.

12 REPORTING RESULTS

Note: In addition to other required results, vapor recovery system test results shall be reported in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

The following are required by § 10 RECORDING DATA:

(1) **Chain of Custody**

(2) **Necessary and Sufficient Data**

(3) **Reconciliation of Reported Results to Recorded Data**

(4) **Permanent Records**

Example report forms are provided in Forms 1 through 4 for generating written documents to meet these requirements. Other formats can be used; however, no test report shall be accepted or approved unless it contains at least the information specified in these forms.

All such forms must be written and submitted on acceptable media as specified by the the ARB Executive Officer on a case-by-case basis for each report.

In cases of conflict between hard copy and soft copy documents, the hard copy shall be presumed correct, unless a different determination is made by the ARB Executive Officer in special circumstances, which must be documented, in hard copy and soft copy, to the satisfaction of the ARB Executive Officer.

13 ALTERNATIVE TEST PROCEDURES

13.1 General Alternative Test Procedures

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.

(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

13.2 Test Procedures for Determining Incinerator Emissions

Incinerator emissions shall be determined using the procedures of EPA M-2B with the additional requirements provided in TP-205.2.

14 REFERENCES

This section is reserved for future specification.

15 EXAMPLE FIGURES AND FORMS

15.1 Figures

Each figure provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the figures are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

Figure 1
Test Locations

Figure 2
Test Point 1 (Nozzle Sleeve)

Figure 3
Vehicle Leak Check Procedure (Nitrogen Pressurization)

Figure 4
Vehicle Leak Check Procedure: (Manual Compression)

Figure 5
Vehicle Leak Check Procedure: (Manual De-Compression)

Figure 6
Nozzle Sleeve Assembly: (Sectional View of Sleeve)

Figure 7
Nozzle Sleeve Assembly: (Axial View of Sleeve)

Figure 8
Nozzle Sleeve Assembly: (View of Sleeve on Nozzle)

Figure 9
Leak Check of Sleeve: (View of Combustible Gas Detector)

Figure 10
Leak Check of Sleeve: (View of Combustible Gas Detector in Use)

Figure 11
Nozzle Sleeve Measurements: (Volume Measurement)

Figure 12
Nozzle Sleeve Measurements: (Concentration Measurement)

Figure 13
Test Point 2 (Vapor Return Line)

Figure 14
Vapor Return Line (Volume Measurement, General)

Figure 15
Vapor Return Line (Volume Measurement, Single Vapor Return Line)

Figure 16
Vapor Return Line (Volume Measurement, Manifolded Vapor Return Lines)

Figure 17
Vapor Return Line (Concentration Measurement)

Figure 18
Test Point 3 (Vent and/or Assist Processor)

Figure 19
Single Vent (Volume Measurement)

Figure 20
Manifolded Vents (Volume Measurement)

Figure 21
Vent or Vents (Concentration Measurement)

15.2 Forms

Each form provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the forms are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

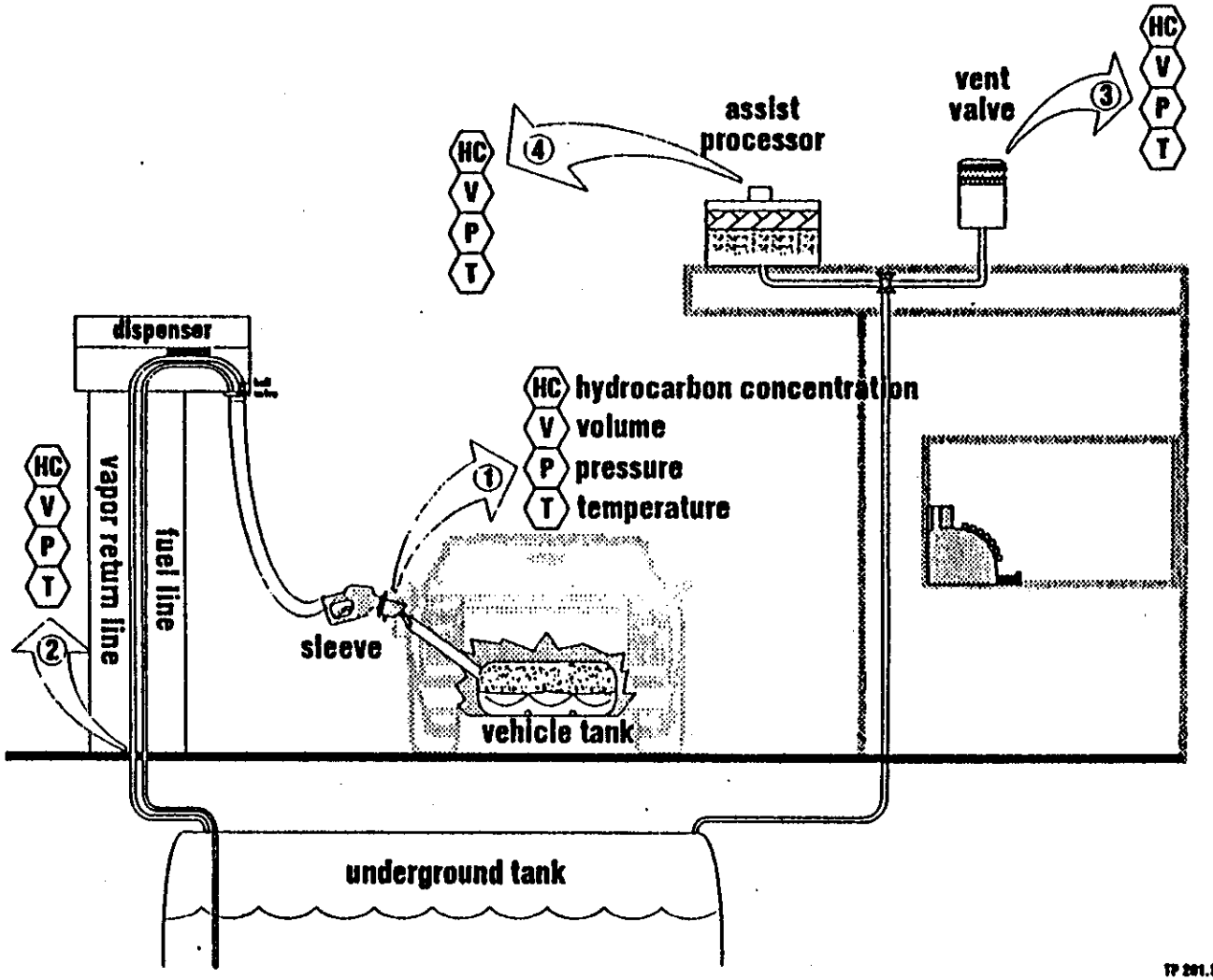
Form 1
Chain of Custody

Form 2
Data

Form 3
Results

Form 4
Permanent Records

FIGURE 1
Test Locations



TP 201.2 F.V.R. CORDOVA '96

FIGURE 2
Test Point 1 (Nozzle Sleeve)

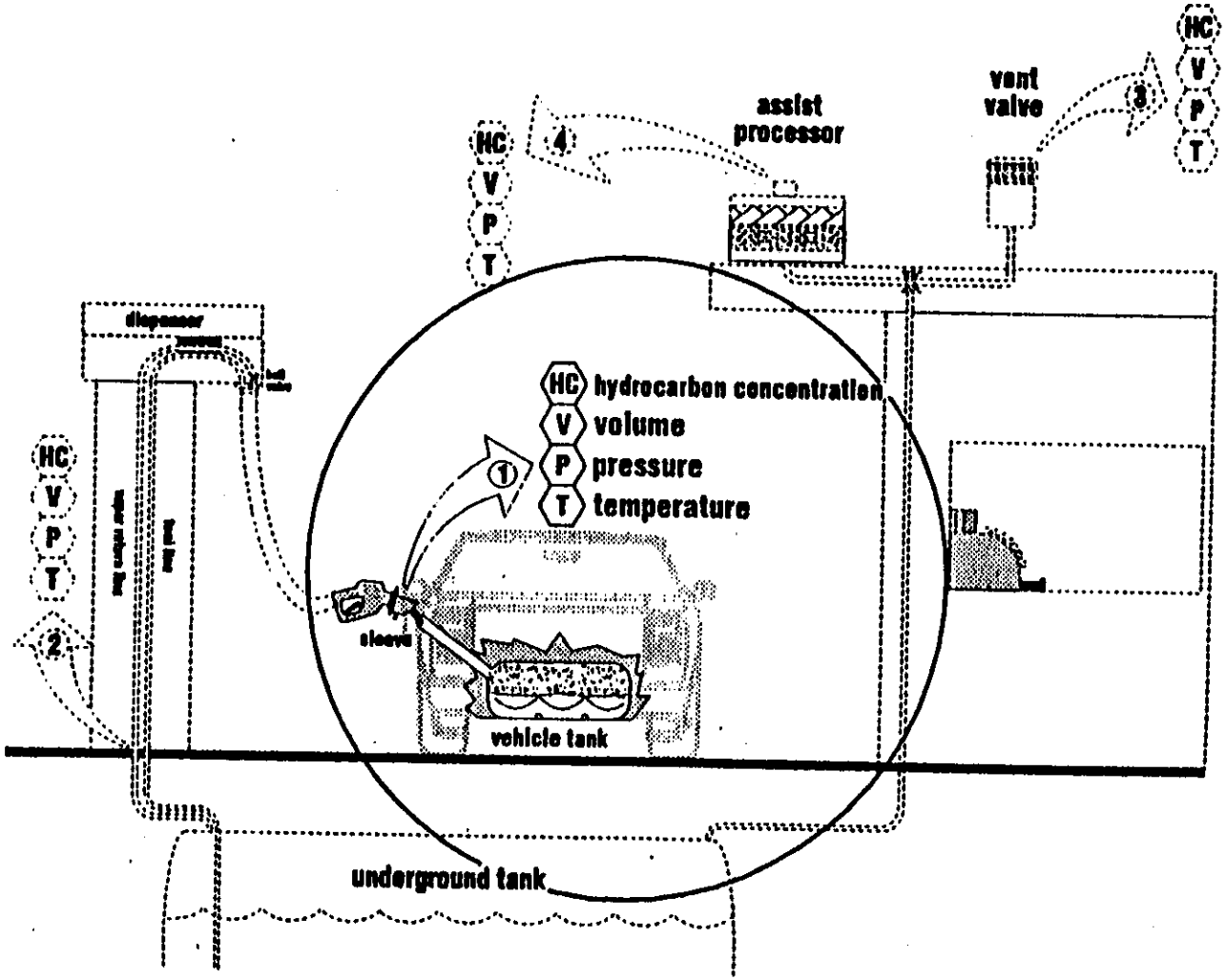
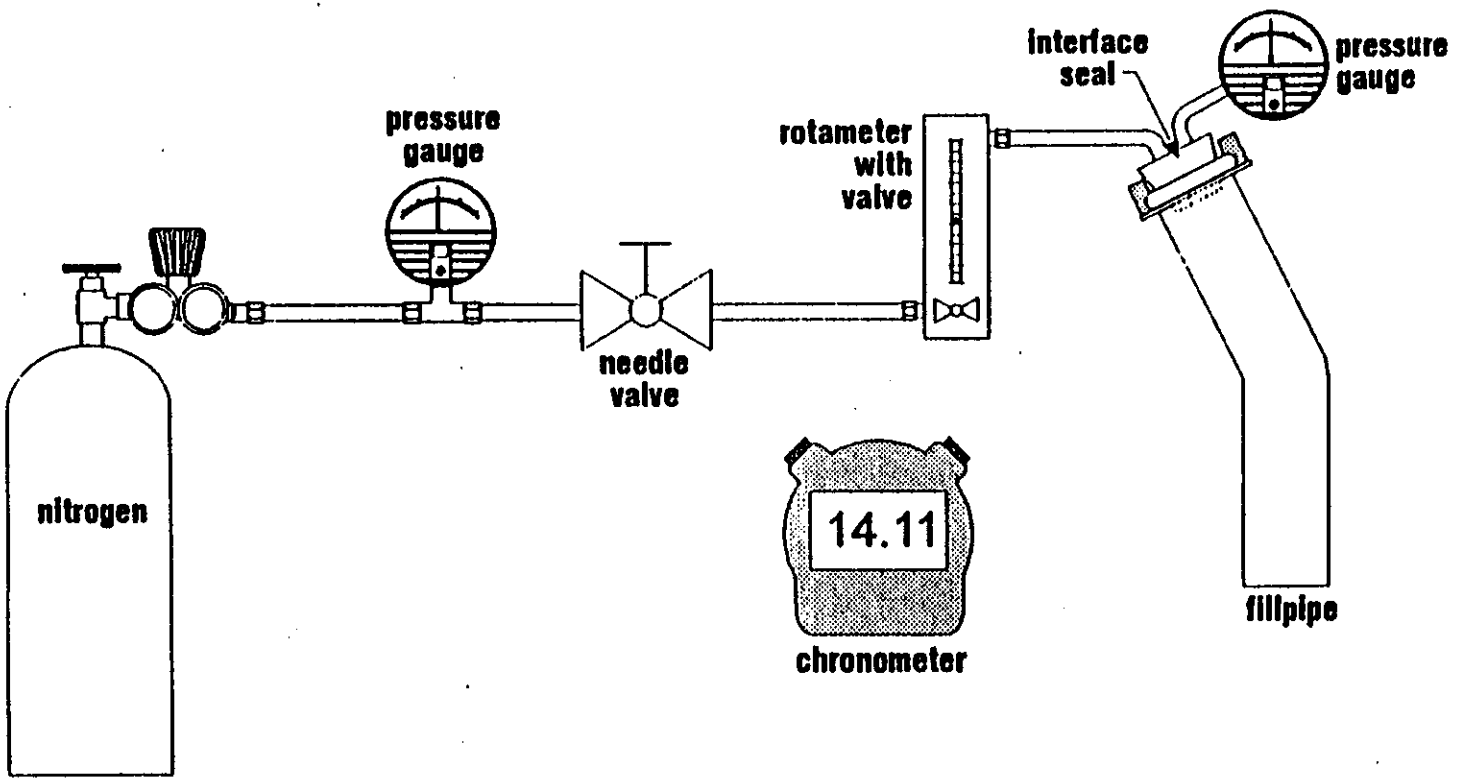
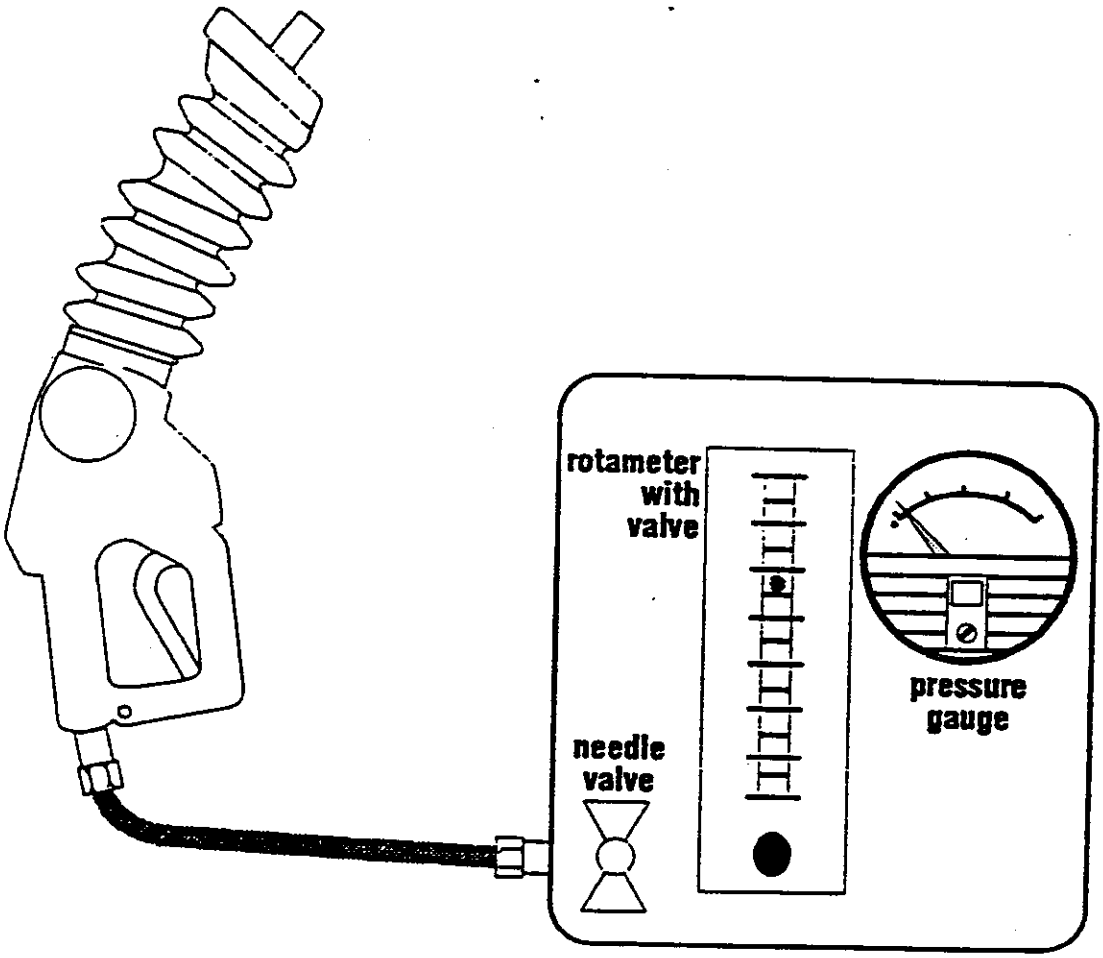


FIGURE 3
Vehicle Leak Check Procedure (Nitrogen Pressurization)



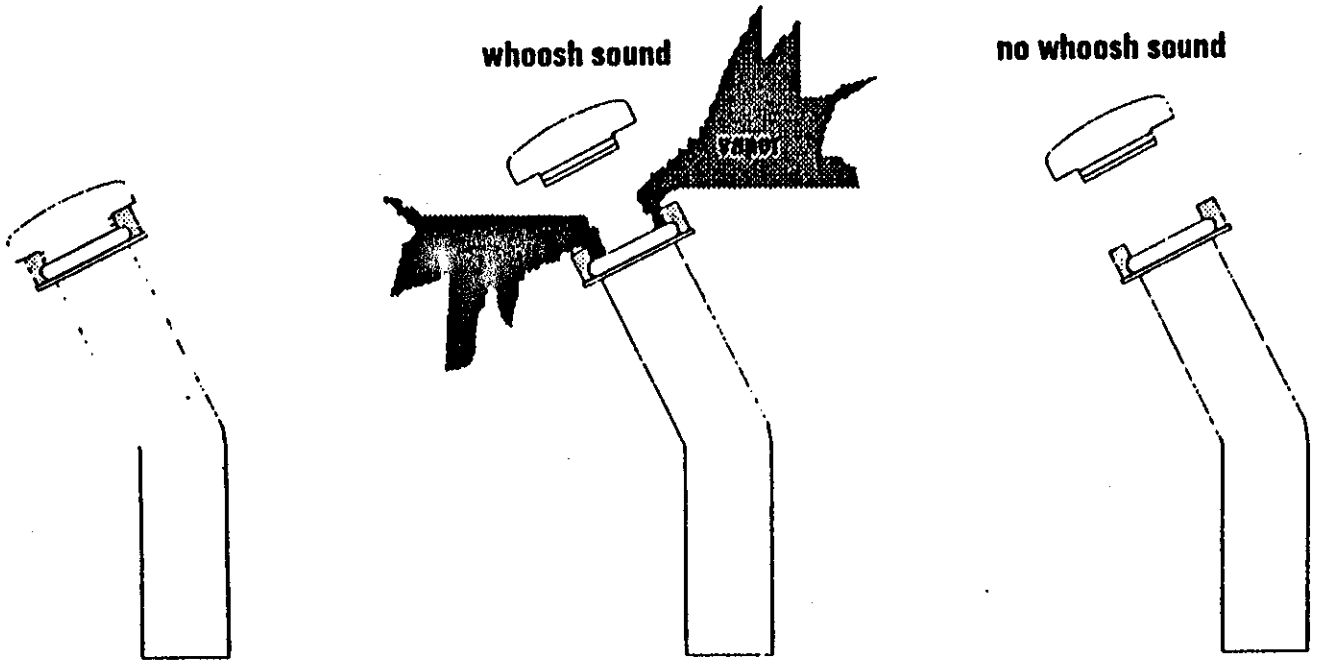
TP 201.2 F.V B. CORDOVA '96

FIGURE 4
Vehicle Leak Check Procedure
(Manual Compression)



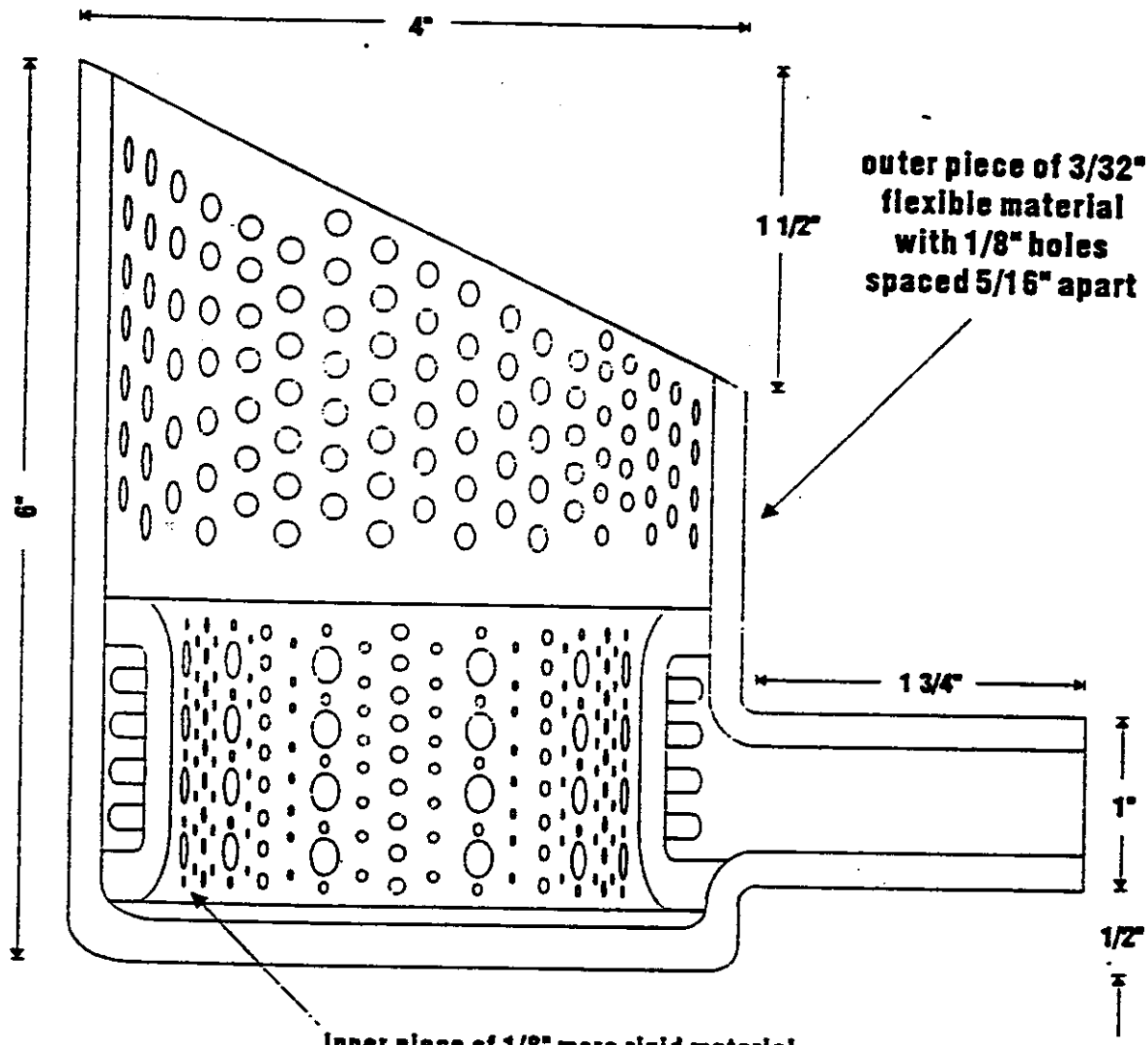
TP 201.2 F.A/ S. CORDOVA '96

FIGURE 5
Vehicle Leak Check Procedure
(Manual De-Compression)



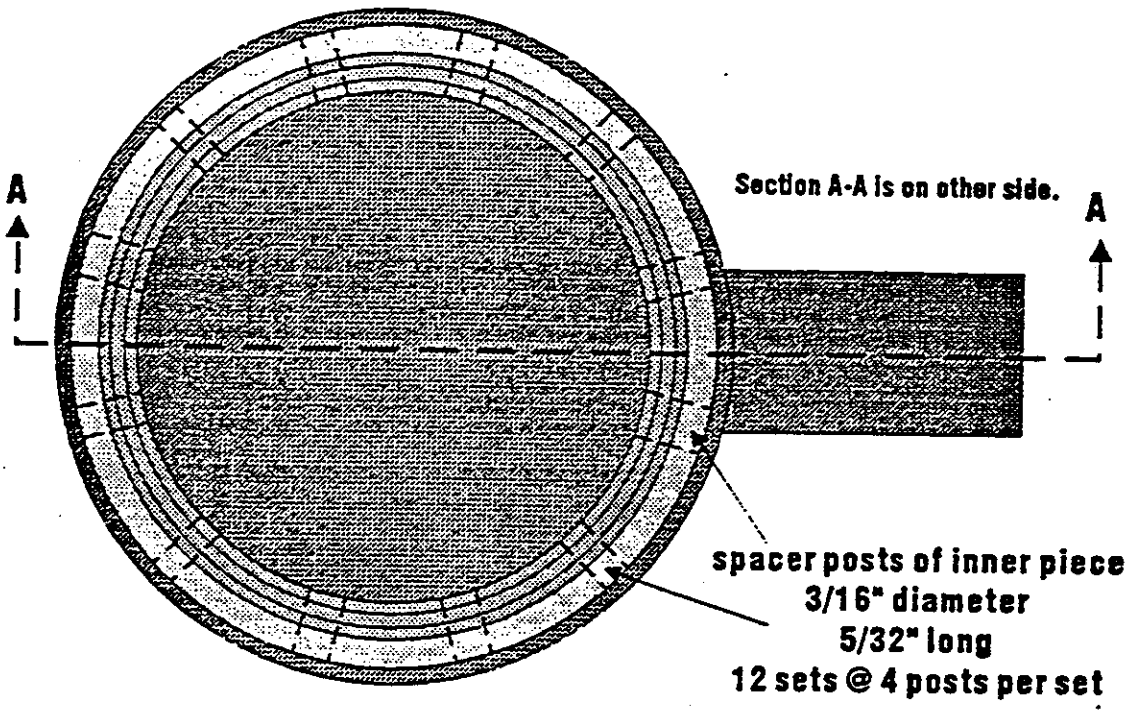
TP 201.2 F.V.R. CORDOVA '96

FIGURE 6
Nozzle Sleeve Assembly (Sectional View of Sleeve)



these dimensions are for example, and are not specifications

FIGURE 7
Nozzle Sleeve Assembly (Axial View of Sleeve)



Materials must be resistant to breakdown by fuels and additives and easily bonded and repaired.

TP 201.2 F.7/ 8. CORDOVA '96

FIGURE 8
Nozzle Sleeve Assembly (View of Sleeve on Nozzle)

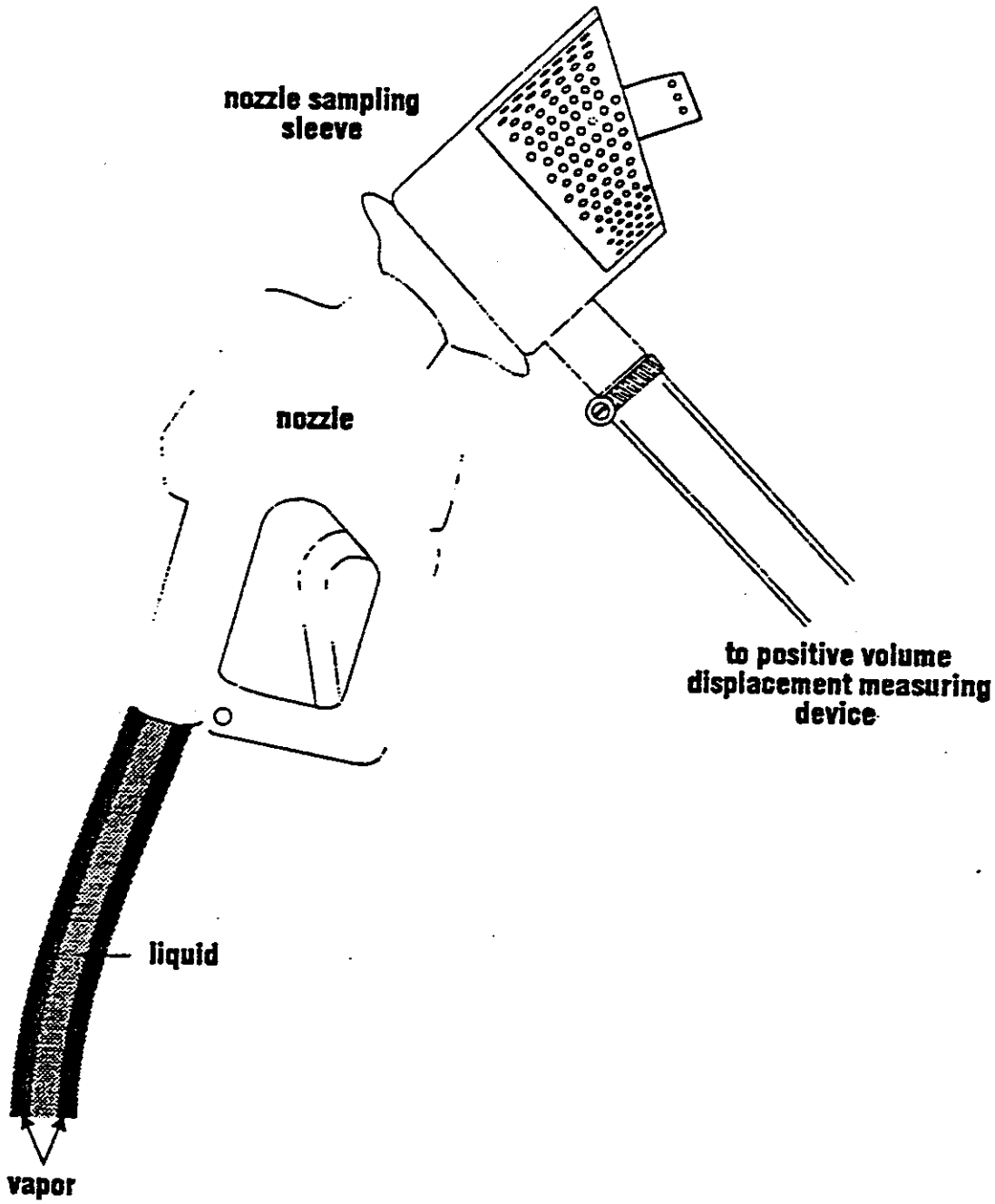


FIGURE 9
Leak Check of Sleeve (View of Combustible Gas Detector)

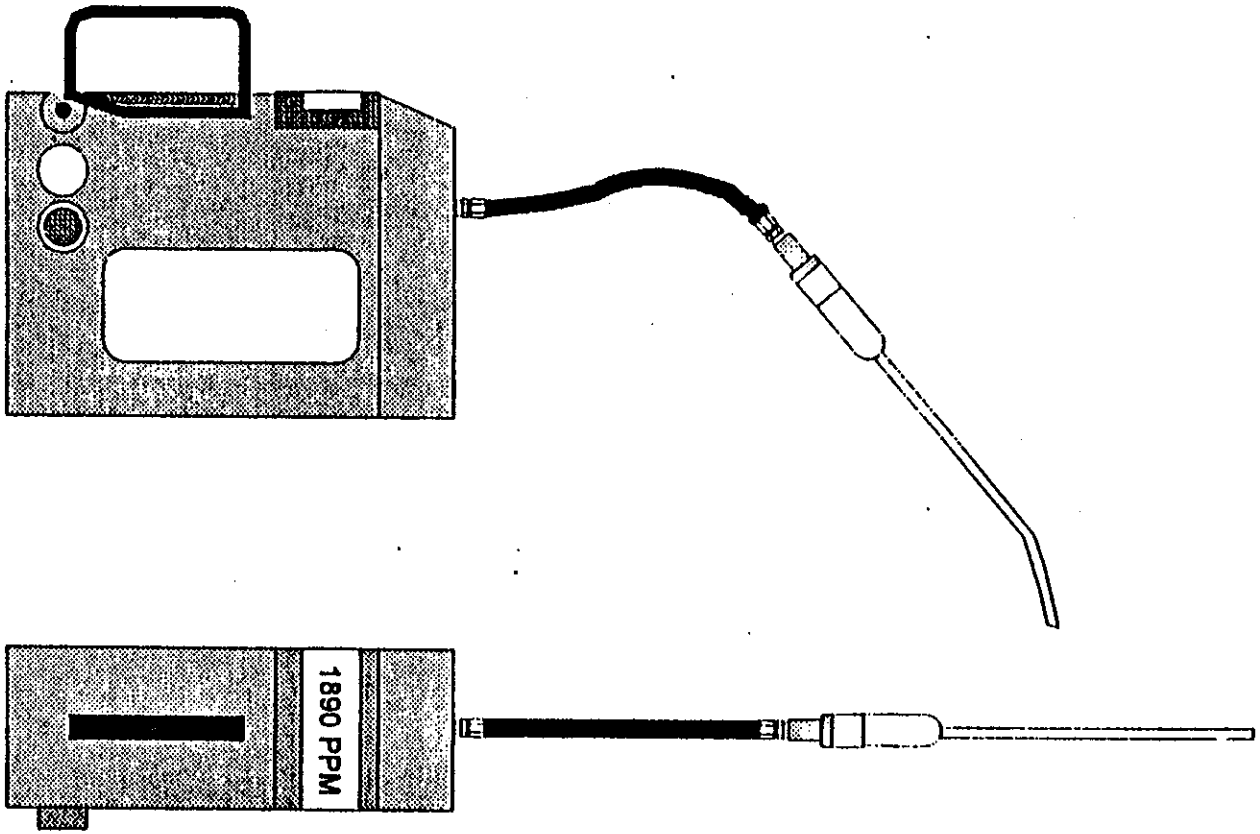


FIGURE 10
Leak Check of Sleeve (Combustible gas detector in Use)

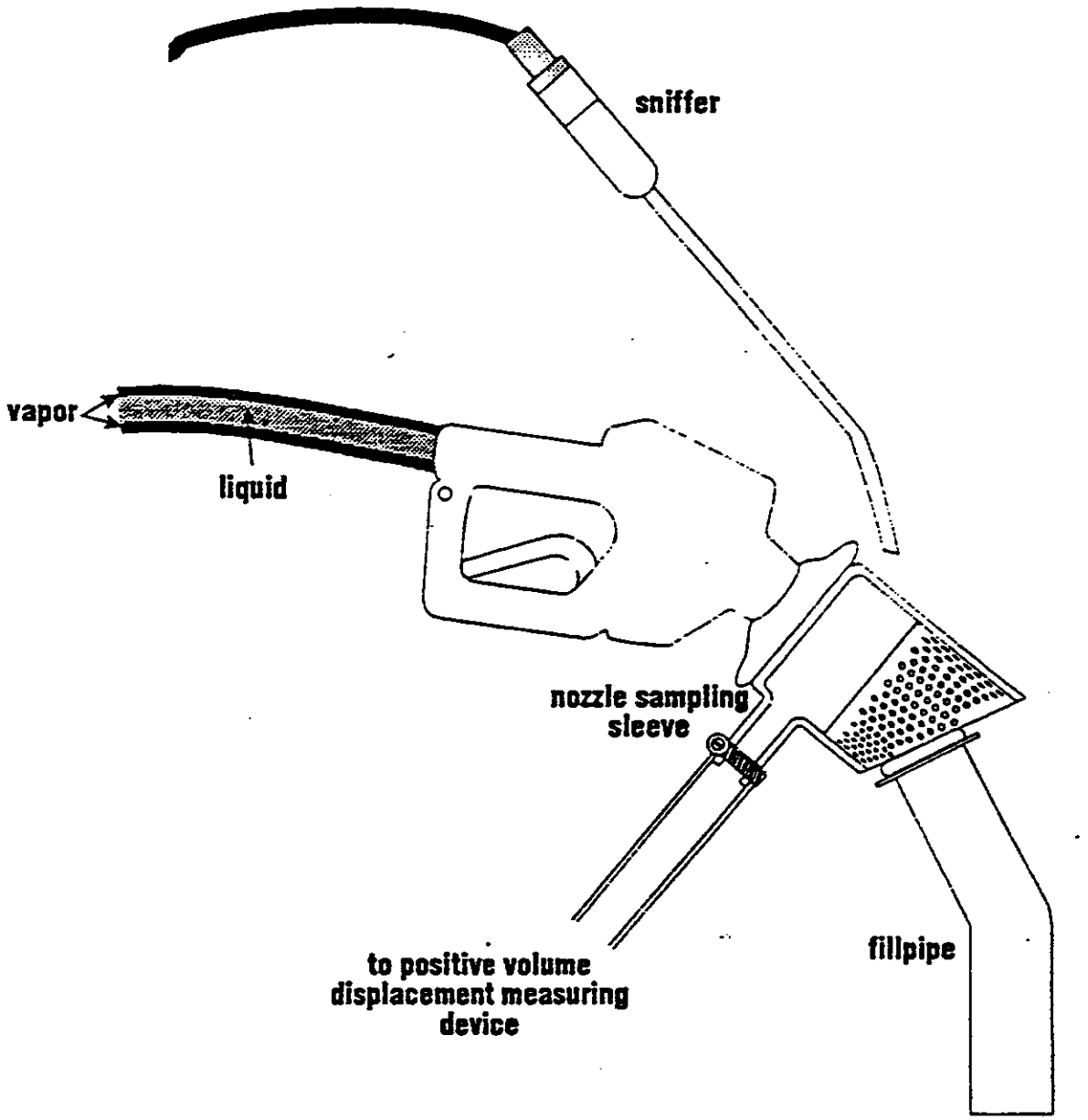
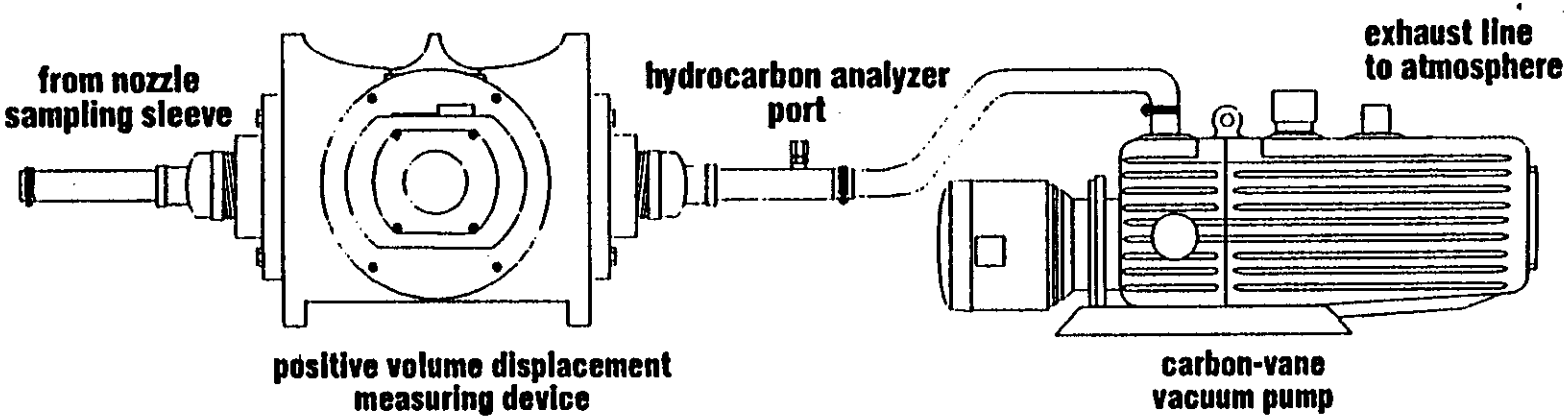
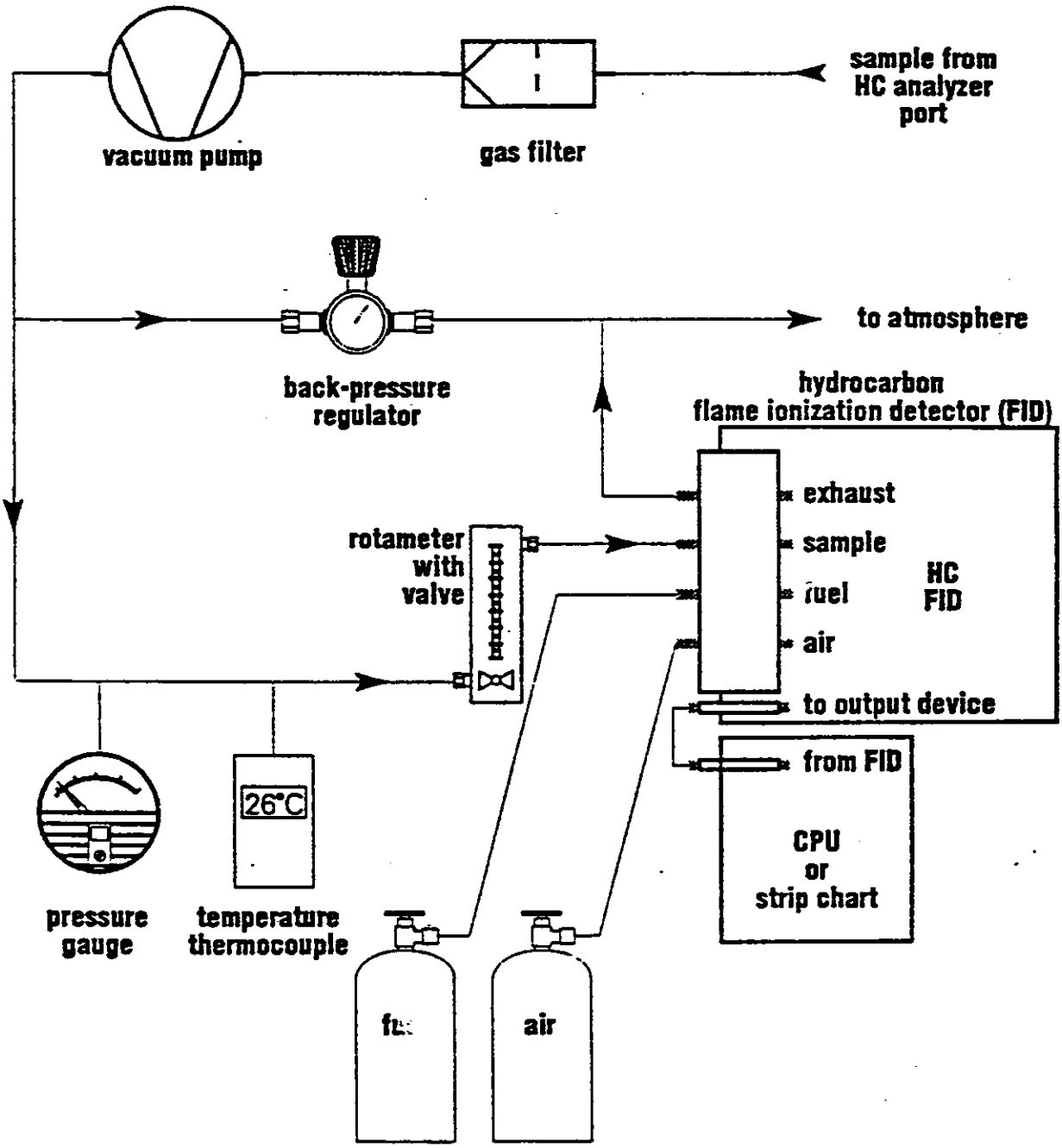


FIGURE 11
Nozzle Sleeve Measurement (Volume Measurement)



TP 201.2 F.11/ B. CORDOVA '96

FIGURE 12
Nozzle Sleeve Measurements (Concentration Measurements)



TP 201.2 F.12/ B. CORDOVA '96

FIGURE 13
Test Point 2 (Vapor Return Line)

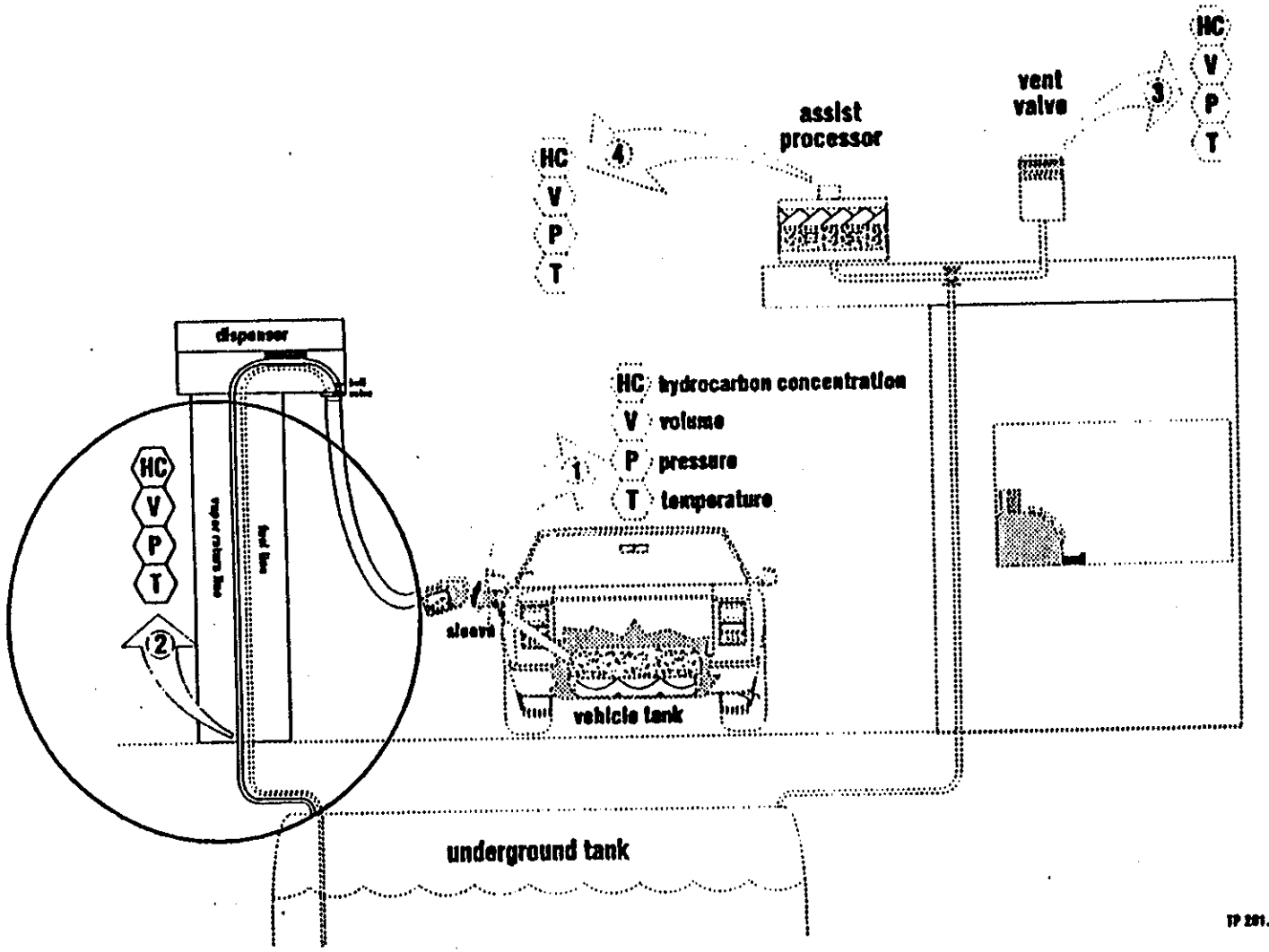


FIGURE 14
Vapor Return Line (Volume Measurement, General)

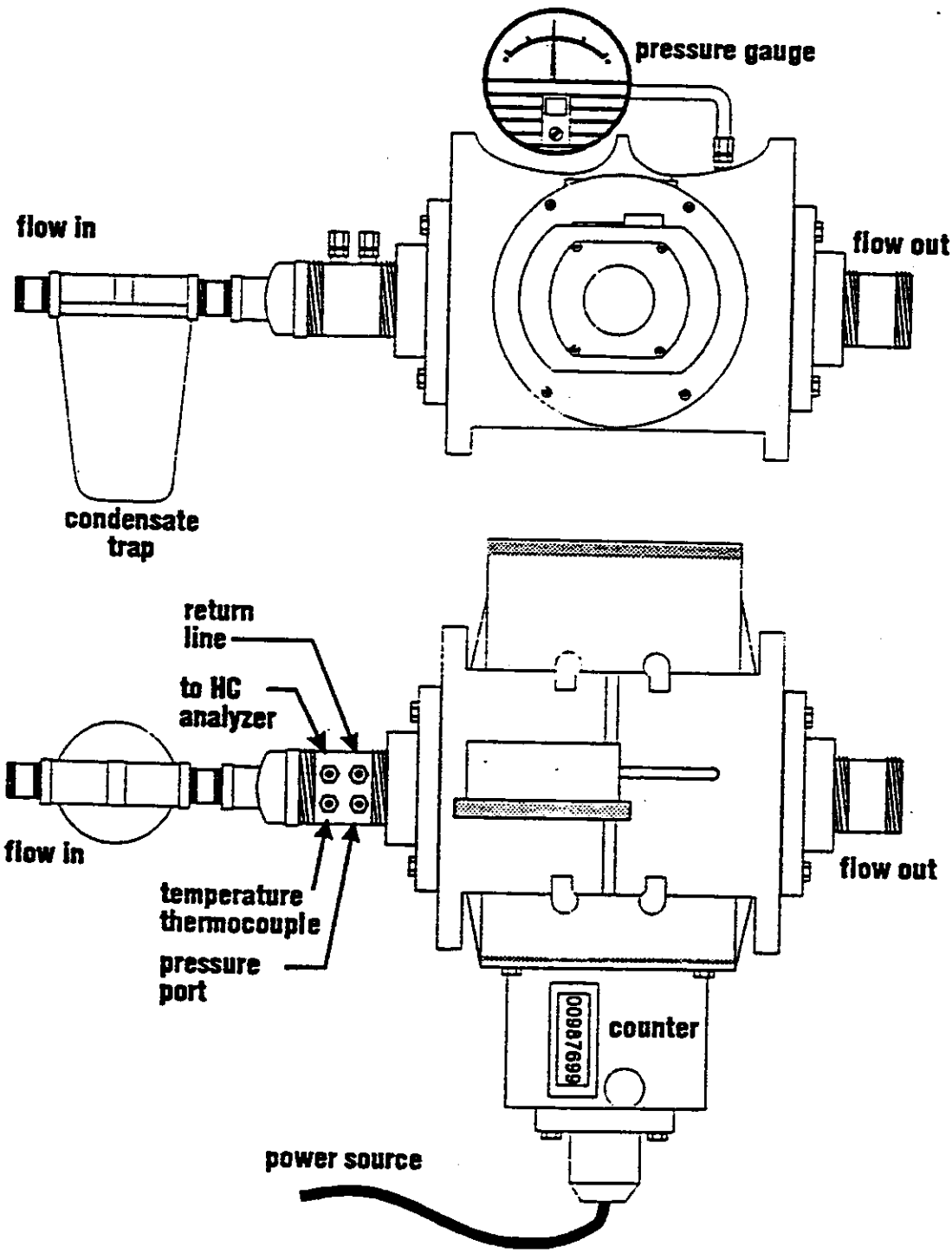
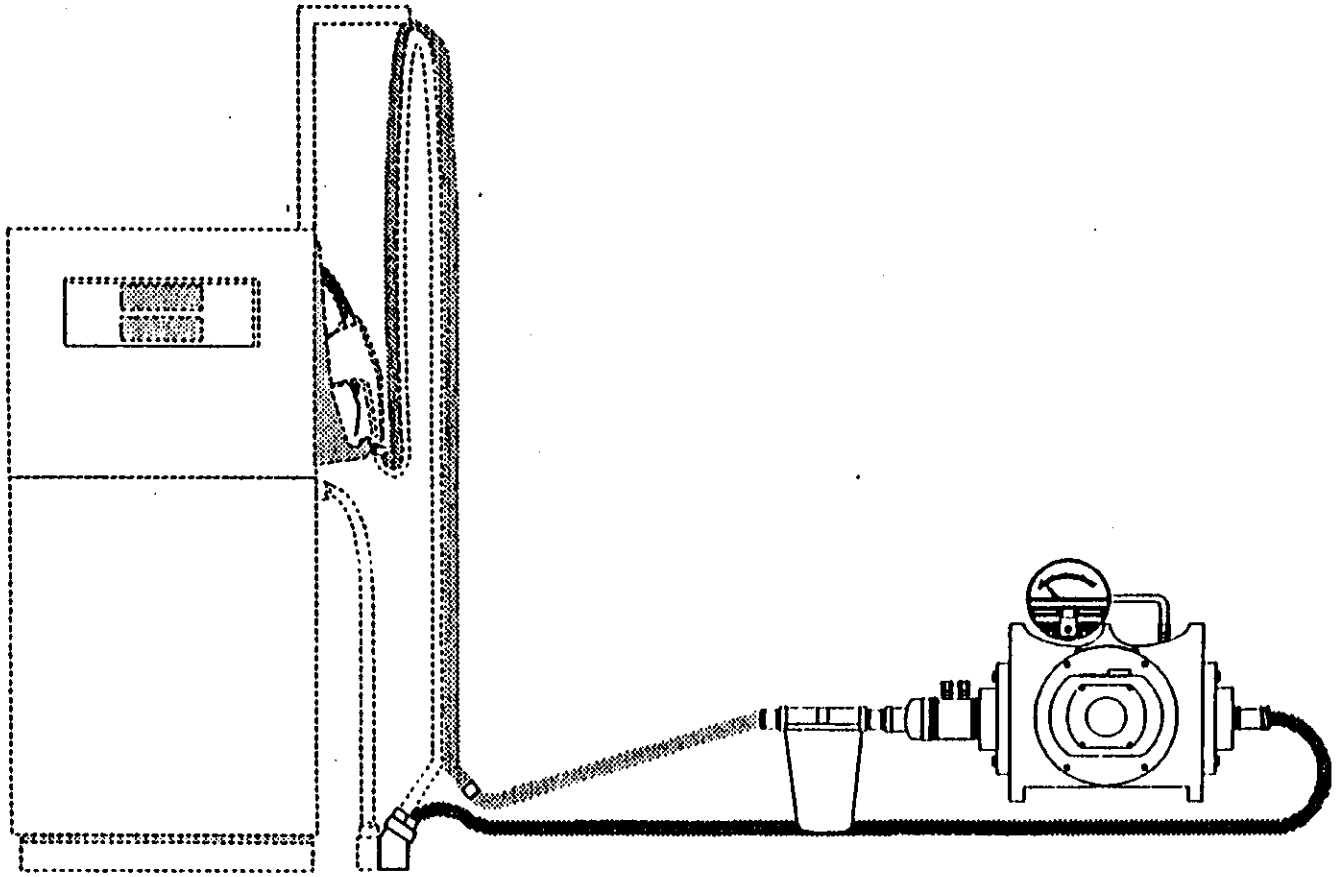
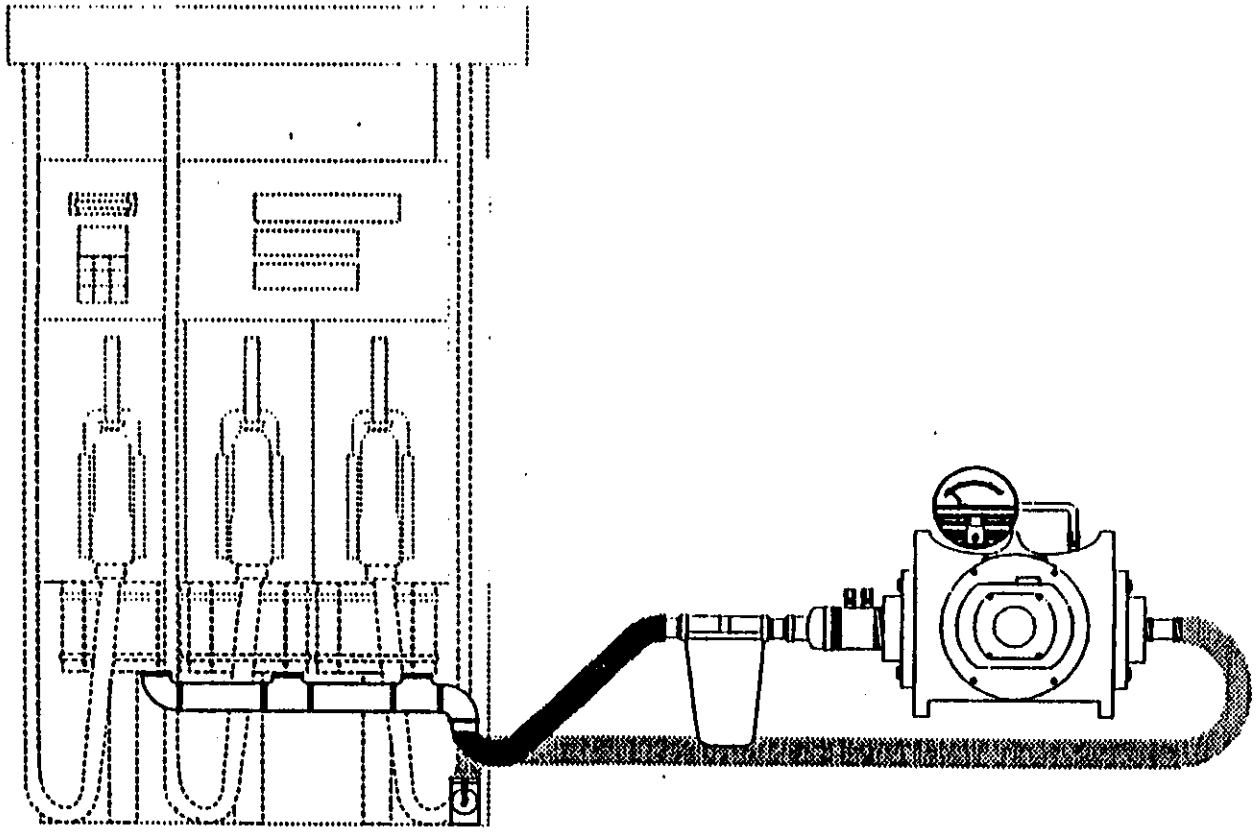


FIGURE 15
Vapor Return Line
(Volume Measurement, Single Vapor Return Line)



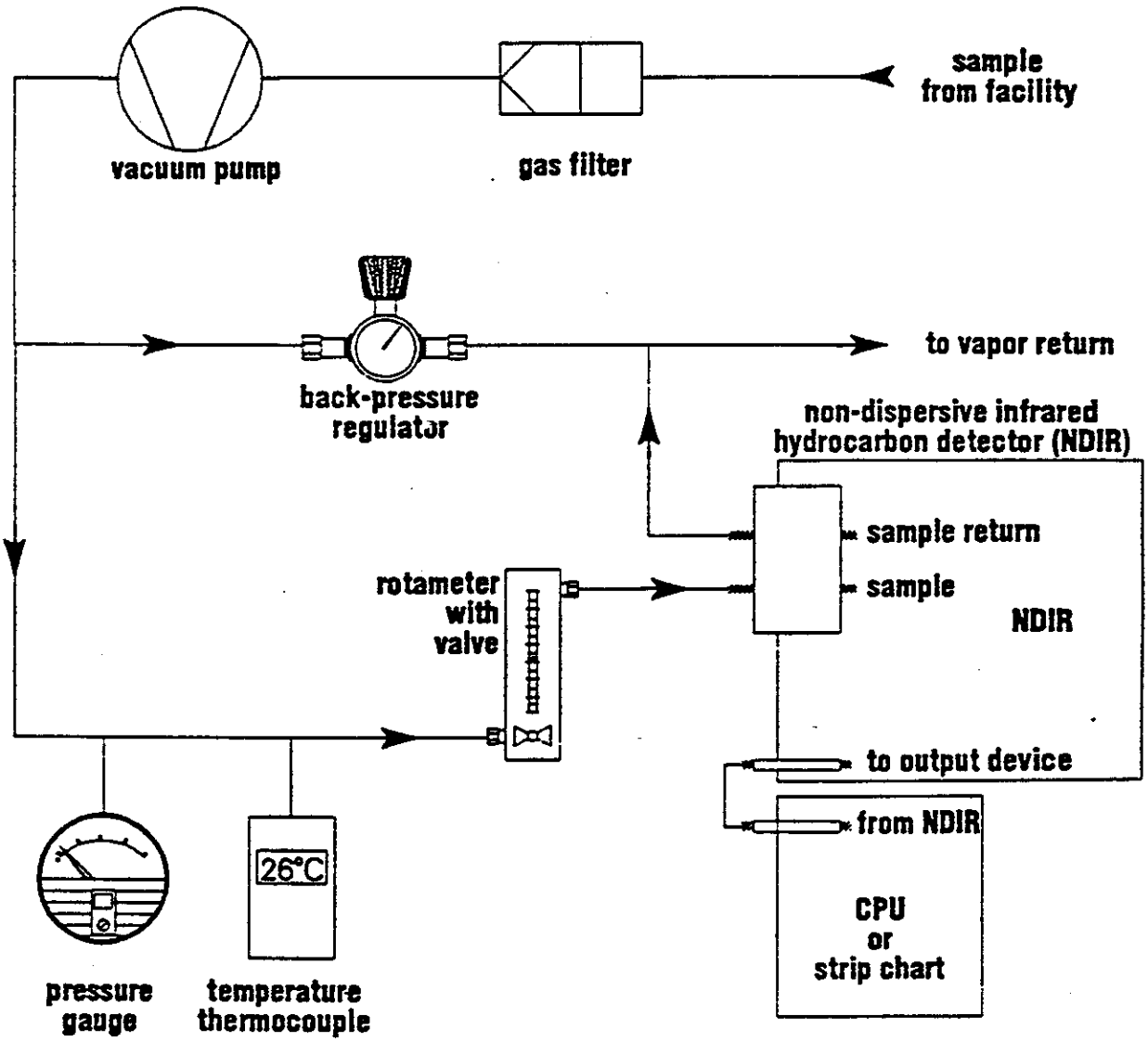
TP 201.2 F.15/ B. CORDOVA '96

FIGURE 16
Vapor Return Line
(Volume Measurement, Manifolded Vapor Return Lines)



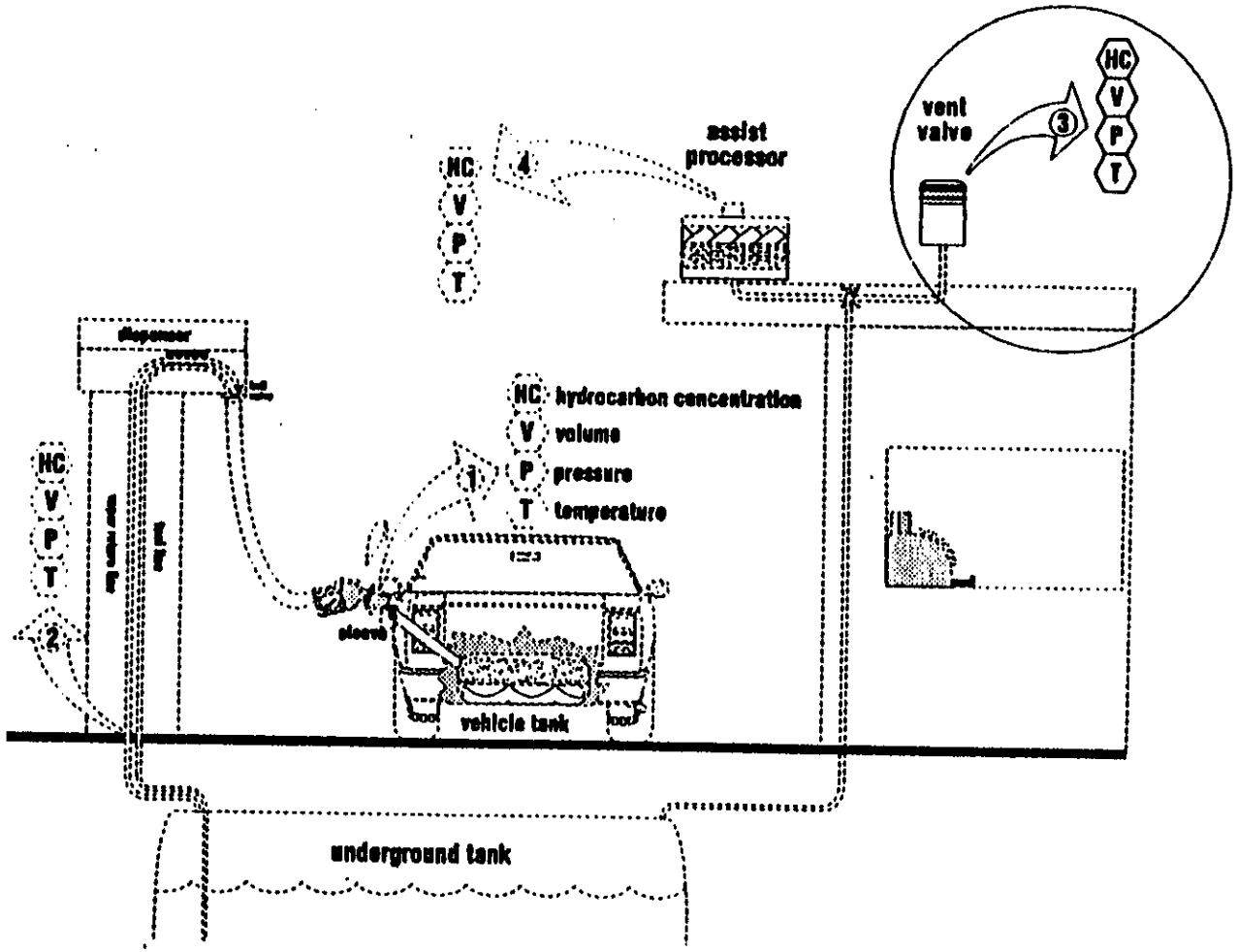
TP 201.2 F.16/ B. CORDOVA '96

FIGURE 17
Vapor Return Line (Concentration Measurement)



TP 201.2 F.17/ S. CORDOVA '96

FIGURE 18
Test Point 3 (Vent and/ or Assist Processor)



TP 201.2 F18/ E. CORDOVA '96

FIGURE 19
Single Vent (Volume Measurement)

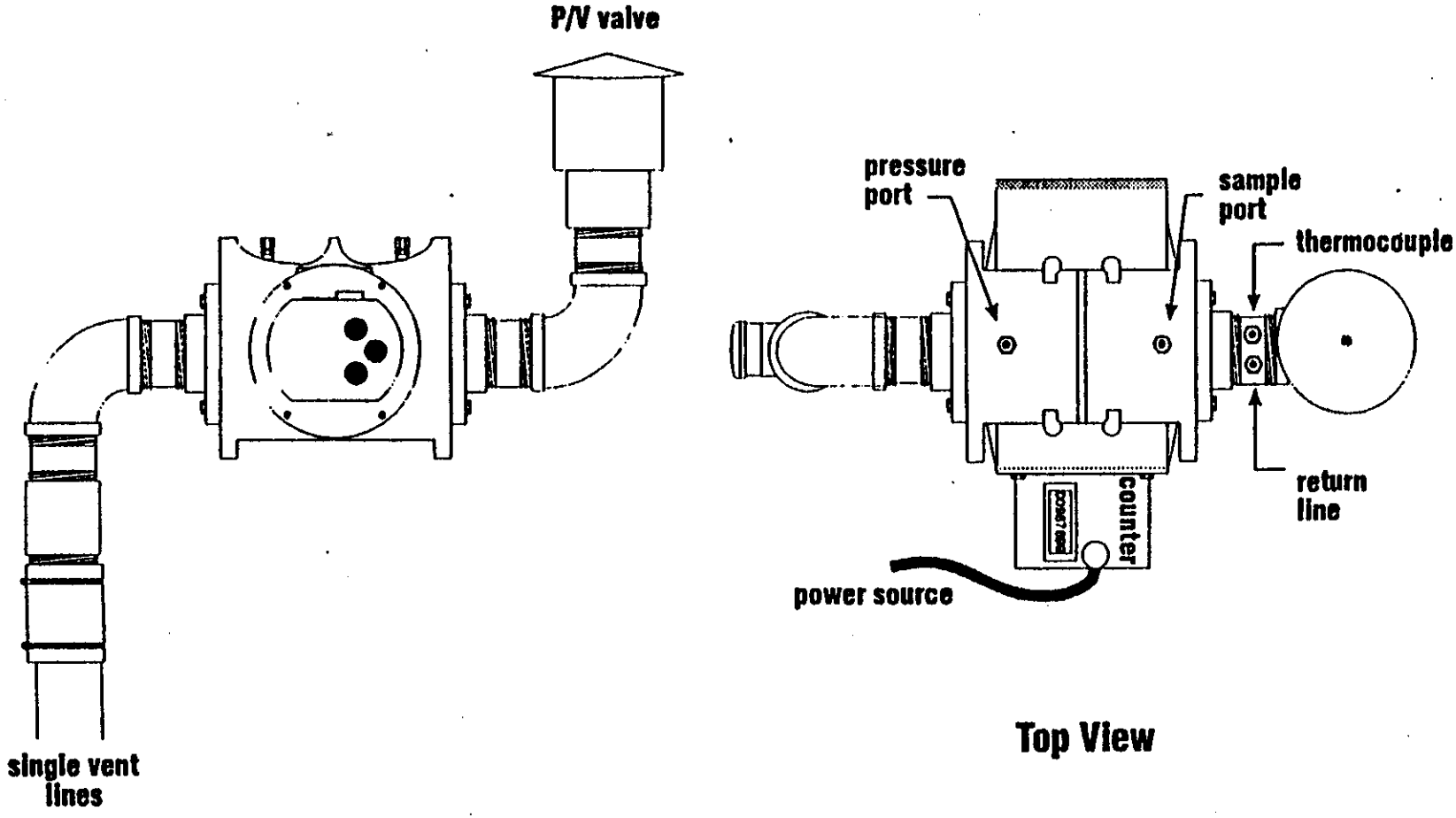
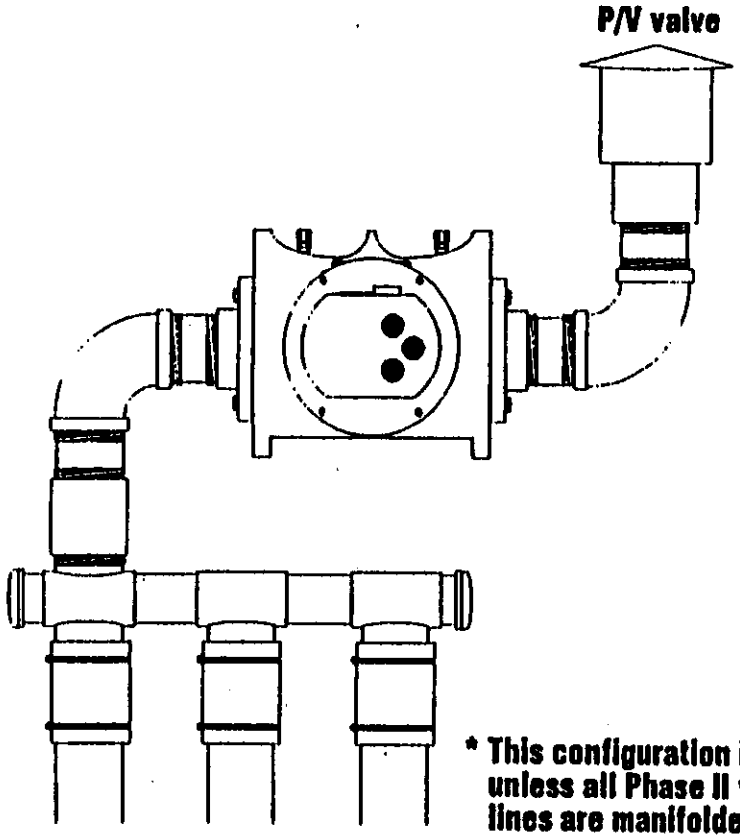
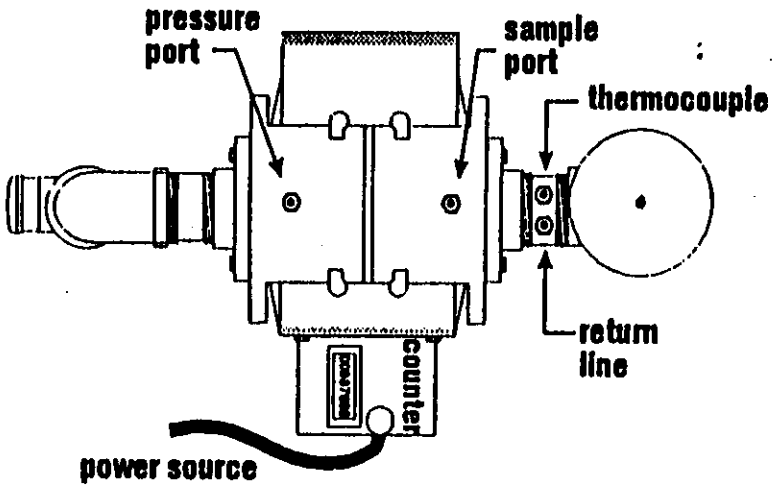


FIGURE 20
Manifolded Vents (Volume Measurement)



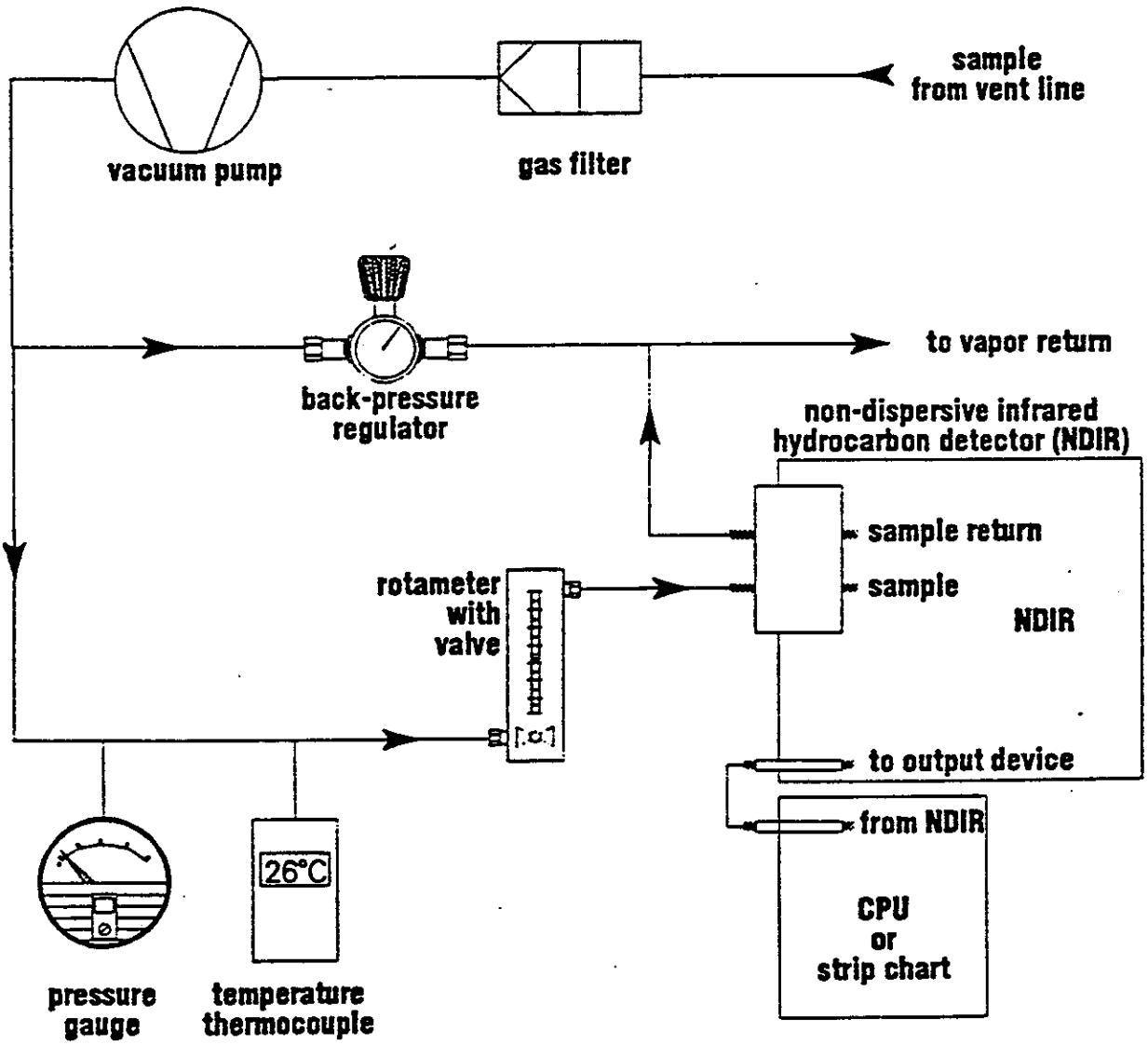
* This configuration is not allowed unless all Phase II vapor return lines are manifolded.



Top View

TP 201.2 F.DV B. CORDOVA '95

FIGURE 21
Vent or Vents (Concentration Measurement)



Form 1
Chain of Custody

System Description		Location			
Date of Application		Tester			
Code # & Description of Item Transferred	Condition of Item Transferred	Given by	Taken by	Date	Time

Form 2
Data
Test Point 1

System Description				Location			
Date				Tester			
Time	Episode #	$[HC]_{(vapor)}$	$V_{(vapor)}$	$P_{(vapor)}$	$T_{(vapor)}$	$V_{(liquid)}$	$RVP_{(liquid)}$

Form 2
Data
Test Point 2

System Description				Location			
Date				Tester			
Time	Episode #	$[HC]_{(vapor)}$	$V_{(vapor)}$	$P_{(vapor)}$	$T_{(vapor)}$	$\Delta P_{(dynamic)}$	Phase II Notes

Form 2
Data
Test Point 3

System Description				Location			
Date				Tester			
Time	Episode #	$[HC]_{(vapor)}$	$V_{(vapor)}$	$P_{(vapor)}$	$T_{(vapor)}$	$P_{(valve\ crack)}$	Phase I Notes

Form 2
Data
Test Point 4

System Description					Location				
Date					Tester				
Time	Episode #	$V_{(facility)}$	$[HC]_{(fac.)}$	$V_{(fuel)}$	$[HC]_{(fuel)}$	$[HC]_{(in)}$	N	CO_2	CO

Form 3
Results
Test Point 1

System Description				Location			
Date				Tester			
Time	Episode #	$V_{(std)}$	$[HC]_{(corrected)}$	$m_{(sleeve)}$	$m_{(idle)}$	m_1	Notes

Form 3
Results
Test Point 2

System Description				Location	
Date				Tester	
Time	Episode #	$V_{(std)}$	$[HC]_{(corrected)}$	m_2	Notes

Form 3
Results
Test Point 3

System Description				Location	
Date				Tester	
Time	Episode #	$V_{(std)}$	$[HC]_{(corrected)}$	m_3	Notes

Form 3
Results
Test Point 4

System Description					Location	
Date					Tester	
Time	Episode #	$V_{(in)}$	$[HC]_{(in)}$	$V_{(out)}$	m_4	Notes

Form 3
Results
Efficiencies

System Description					Location				
Date					Tester				
Time	Episode #	$m_{(e,1)}$	$m_{(e,1)}$	$m_{(e,1)}$	$m_{(e,1)}$	$m_{(e,1)}$	E_e	E	Notes

Form 4
Permanent Records

System Description		Location			
Date of Application		Tester			
Code # & Description of Item Transferred	Condition of Item Transferred	Given by	Taken by	Date	Time

Appendix C

TP-201.2A

DETERMINATION OF VEHICLE MATRIX FOR PHASE II VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES

California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.2A

Determination of Vehicle Matrix for Phase II Vapor Recovery Systems of Dispensing Facilities

Adopted: April 12, 1996

California Environmental Protection Agency
Air Resources Board

Vapor Recovery Test Procedure

TP-201.2A

Determination of Vehicle Matrix for Phase II Vapor Recovery Systems of Dispensing Facilities

1 APPLICABILITY

Definitions common to all certification and test procedures are in:

D-200 Definitions for
Certification Procedures and
Test Procedures for
Vapor Recovery Systems

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

This test procedure can be used to determine the characteristics of a test fleet of vehicles which, when tested by other test procedures, can yield data representative of the total vehicle fleet.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The sample of vehicles to be used in method TP-201.2 for testing vapor control systems shall be made up of vehicles representative of the on the road vehicle population in terms of vehicle miles traveled (VMT). This calculation procedure produces such a representative vehicle matrix. The distribution in terms of model year can be derived from the VMT portion of the calculated input to EMFAC. EMFAC is the ARB computer model for estimating on road motor vehicle emissions and is administered by the Technical Support Division of ARB. Distribution in terms of manufacturer can be derived from the number of registered vehicles for each make and model year which can be obtained from the Department of Motor Vehicles.

3 BIASES AND INTERFERENCES

This section heading is not applicable to this procedure.

4 SENSITIVITY, RANGE, AND PRECISION

This section heading is not applicable to this procedure.

5 EQUIPMENT

This section heading is not applicable to this procedure.

6 CALIBRATION PROCEDURE

This section heading is not applicable to this procedure.

7 PRE-TEST PROTOCOL

This section heading is not applicable to this procedure.

8 TEST PROCEDURE

This section heading is not applicable to this procedure.

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

This section heading is not applicable to this procedure.

10 RECORDING DATA

This section heading is not applicable to this procedure.

11 CALCULATING RESULTS

The vehicle makes and models and the number of vehicles per cell in the examples below are for illustration purposes only. More cells and other models and different numbers of vehicles per cell shall be included at the discretion of the ARB Executive Officer.

11.1 Vehicle Make

Obtain the number of registered vehicles by manufacturer and by model year from the Department of Motor Vehicles (DMV). The data shall resemble the following :

Number of Registered Vehicles

MODEL (e.g.)	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHER	TOTAL
YEAR							
1991	109,563	344,867	334,974	218,577	191,174	378,731	1,577,886
1990	138,427	352,293	323,953	203,156	189,973	460,906	1,668,708
etc.							

11.2 Vehicle Miles Traveled (VMT)

Obtain data for the projected vehicle miles traveled (VMT) in the current year from EMFAC7EWT output. This is the vehicle population, trip, and VMT fraction input data for EMFAC. The required data are the fractions of the total VMT by each vehicle model year. The passenger car population for this data set is divided into three groups; non-catalytic gasoline, catalytic gasoline, and diesel powered. Use only the catalytic gasoline vehicles for this calculation. The data will appear similar to the following:

Distribution of VMT by Vehicle Model Year

MODEL YEAR	PERCENT OF VMT	VEHICLES PER 100 CAR TEST
1991	6.9	6.9
1990	10.5	10.5
1989	10.7	10.7
1988	10.3	10.3
1987	9.3	9.3
1986	8.2	8.2
1985	7.4	7.4
1984	6.7	6.7
1983	6.0	6.0
1982	5.2	5.2
1981	4.7	4.7
1980	4.1	4.1
1979	2.9	2.9
1978	2.4	2.4
1977	2.0	2.0
1976	1.5	1.5
1975	1.1	1.1
1974	0	0

The diesel vehicles are not fueled with vapor recovery equipment and shall not be included in the matrix. The non-catalytic vehicles were produced before 1979 and most were built before fillpipe standards and vapor emission standards were established for vehicles. They currently account for only 4% of the total VMT's and this fraction decreases each year. So the non-catalytic vehicles also need not be included in the matrix.

11.3 VMT per Make and Model Year

Multiply the VMT fraction for each model year (step 11.2) times the number of registered vehicles by each manufacturer (step 11.1) for the corresponding model year. The resulting products are proportional to the miles traveled by each manufacturer's vehicles, for each model year.

11.4 VMT per Make for All Years

Sum the products of step 11.3 for each manufacturer. These sums represent the total VMT for each manufacturer. Select at least five manufacturers responsible for the highest VMT sums. These five (or more) manufacturers will be used to establish columns in the matrix. A last column called "Others" will include the vehicles from all other manufacturers.

11.5 Percentage of Vehicles for each Model Year

Determine the number of vehicles from each model year which are required by the 100-car matrix. To do this, convert the VMT fractions of step 11.2 to percents by multiplying by 100%. These percent numbers also equal the number of vehicles required in the 100-car test for each model year. For example if 10% of all VMT's are traveled by 1990 model vehicles, the 100-car matrix would include ten 1990 vehicles.

It is most accurate to maintain fractions through the calculations and round to whole vehicle numbers only at the last step of determining the matrix.

11.6 Percentage of Vehicles by Make for each Model Year

Obtain the fractions of registered vehicles by manufacturer for each model year. This shall be done for the five main manufacturers (step 11.4) and for the "Others" total. First, sum the numbers of registered vehicles of all manufacturers for each model year. Second, divide this sum into the registered vehicle numbers of each of the five main manufacturers and "Others" to get the desired fraction. For example, a recent calculation yielded:

Percentage of Registered Vehicles by Manufacturer for Each Model Year

MODEL	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHERS	TOTAL
YEAR							
1991	6.9	21.9	21.2	13.9	12.1	24.0	100.0%
1990	8.3	21.1	19.4	12.2	11.4	27.6	100.0%
etc.							

11.7 **Yearly Matrix Values**

Distribute the vehicles for each model year (step 11.5) among the six columns (step 11.4). The number of vehicles assigned for each manufacturer shall be proportional to the fraction of registered vehicles (step 11.6) for each model year. A recent example follows:

Number of Vehicles for 100-car Matrix by Manufacturer and Model Year

MODEL	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHERS	TOTAL
YEAR							
1991	0.48	1.51	1.46	0.96	0.83	1.66	6.9
1990	0.87	2.22	2.04	1.28	1.20	2.90	10.5
etc.							

11.8 Vehicle Matrix

The vehicle matrix shall be constructed per the requirements of the certification procedure. Examples for two such requirements are given below:

11.8.1 Vehicle Cell Limits

The following example shows the results of constructing a vehicle matrix for August 1992 with a ten vehicle cell limit. Any other matrix with another cell limits, such as less than five vehicles per cell, shall be constructed in the same manner.

Combine the data into groups of model years to facilitate filling the matrix during the 100-car field test. Beginning with the current year, add previous years in succession until a maximum of ten vehicles accumulate in any cell. This group of model years will form the first row of cells. Repeat this process starting with the next preceding year to determine the group of years for the second row of cells. Repeat until all previous years combined yield less than 10 vehicles in any cell. This will normally require four rows of cells and the result will resemble the following table:

100 VEHICLE MATRIX
AUGUST 1992

MODEL YR	CHRYSLER	FORD	GM	TOYOTA	HONDA	OTHER	TOTALS
89-92	2	6	5	4	3	7	27
86-88	3	5	5	4	2	8	27
82-85	2	4	6	3	2	7	24
77-81	1	3	5	2	1	4	16
< 77	1	2	2	0	0	1	6
TOTALS	9	20	23	13	8	27	100

Be careful when rounding to whole numbers of vehicles. This can result in a matrix with slightly more or less than 100 vehicles. One can often determine the best place to add or subtract a vehicle by comparing the sums of rounded numbers and unrounded numbers for each row and column.

11.8.2 Special Cell Limits

Other cell limits shall be placed outside the totals for vehicle cell limits, as required by the application of the certification procedure.

For example, a requirement for

> "at least five vehicles with 89-92 model years with a vehicle tank vapor return line entering the fillpipe above the unleaded restrictor"

would place a "5" in a special limit column to the right of the "TOTALS" column and in the "89-92" row. The row at the bottom of the table would be unaffected except for the addition of a total cell for the sum of the vehicles required by the special limit.

Regardless of the number of special limits required, the total number of vehicles in the matrix shall remain 100.

Be careful when applying special limits, or the resources required to find suitable vehicles can be increased beyond practical limits.

12 REPORTING RESULTS

This section is reserved for future specification.

13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.

(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

14 REFERENCES

This section is reserved for future specification.

15 FIGURES

This section heading is not applicable to this procedure.

Appendix D

TP-201.2B

DETERMINATION OF FLOW VERSUS PRESSURE FOR EQUIPMENT IN PHASE II VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES

State of California
Air Resources Board

Vapor Recovery Test Procedure

PROPOSED TP-201.2B

Determination (Including Fugitive Emissions) of Efficiency of Phase II Vapor Recovery Systems of Dispensing Facilities

1 APPLICABILITY

A set of definitions common to all certification and test procedures is in:

D-200 **Definitions for Certification Procedures and Test Procedures for Vapor Recovery Systems**

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

A list of symbols and nomenclature used in this procedure is provided in the "REFERENCES" section.

1.1 General

This procedure applies to the determination of fugitive emissions from vapor recovery systems at dispensing facilities by direct measurement and modeling. This procedure applies to any fugitive vapor emissions associated with the dispensing of any fluid, although it is written to reflect application to the hydrocarbon (HC) vapors associated with the dispensing of gasoline.

1.2 Modifications

Modification of this procedure may be necessary for vapors and fluids other than the hydrocarbon vapors associated with the dispensing of gasoline.

Any modification of this method shall be subject to approval by the ARB Executive Officer.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The purpose of this test procedure is to determine the fugitive emissions and the vapor recovery efficiency (including fugitive emissions) at a dispensing facility. Figures 1 through 3 are provided to illustrate some aspects of the principle and summary provided below. Figures are at the end of this document.

2.1 Principle

The mass flux of fugitive emissions from a dispensing facility is the product of the volumetric flow rate and the flow-weighted mass-per-volume concentration.

The volumetric flow rate is based upon data for pressure vs. time from the facility and data for flow vs. pressure from a model of the facility. The model flow vs. pressure data are provide a conversion for the facility pressure vs. time data to flow vs. time data.

The flow-weighted mass-per-volume concentration is based upon data for pressure vs. time from the facility, data for mass-per-volume concentration from specified components at the facility, and data for flow vs. pressure taken from specified components on a model of the facility. The model flow vs. pressure data provide a conversion for the facility pressure vs. time data to flow vs. time data for the specified components. The concentration and flow vs. time data for the specified components provide a basis for the flow-weighted mass-per-volume concentration.

2.2 Summary

As required to determine an emissions parameter and except where otherwise specified, the equipment and procedures specified in the following test methods shall be used.

EPA Method 18	Measurements of Gaseous Organic Compound Emissions by Gas Chromatography
EPA Method 25A	Determination of Total Gaseous Organic Compound Emissions Using a Flame Ionization Detector
EPA Method 25B	Determination of Total Gaseous Organic Compound Emissions Using a Nondispersive Infrared Analyzer

A detailed summary of this test procedure is provided in Figure 4.

3 BIASES AND INTERFERENCES

3.1 Static Pressure Performance, TP-201.3

Because the pressure data collection required by this test procedure are not valid unless the facility complies with the static pressure performance standard required by CP-201, the test procedure for static pressure performance, TP-201.3, shall be used to establish that the facility complies with the static pressure performance standard before and after the performance of this test procedure. If this requirement is not met, this test procedure must be performed again.

3.2 Interference by TP-201.2

Because the concurrent performance of TP-201.2 can interfere with the performance of this test procedure, this test procedure shall be performed during the initial 90 day reliability check required by CP-201.

4 SENSITIVITY, RANGE, AND PRECISION

This section is reserved for future specification. More developments are expected.

5 EQUIPMENT

5.1 Polished Stainless Steel Canisters

Polished stainless steel canisters are used to collect integrated samples for concentration analysis. Ancillary valves and flow meters are used to ensure that a low, constant sample flow rate is achieved which does not create sample artifacts by inducing flow in the vapor recovery system.

5.2 Hydrocarbon Analyzers

Integrated samples for concentration analysis must be analyzed both for total hydrocarbon concentration and for speciated hydrocarbon concentrations. Ancillary standard gases must approximate the range of species and concentrations expected for dispensing facility samples (100ppm$_v$ to 500,000ppm$_v$).

6 CALIBRATION PROCEDURE

This section is reserved for future specification. More developments are expected.

7 PRE-TEST PROTOCOL

Perform TP-201.3, as required below.

8 TEST PROCEDURE

The purpose of this test procedure is to determine the fugitive emissions and the vapor recovery efficiency (including fugitive emissions) at a dispensing facility.

A list of symbols and nomenclature used in this procedure is provided in the "REFERENCES" section. Such symbols are used consistently in this section and in the "CALCULATING RESULTS" section. Figures 1 through 3 are provided to illustrate some aspects of the procedure required below. A detailed summary of this test procedure is provided in Figure 4. The test procedure follows:

Take and permanently record atmospheric pressure readings which are chronologically coordinated with all other readings required by this procedure:

where:

$(P)_{201.2A,\ atm}$ ≡ atmospheric pressure, "WC.

8.1 **Find $(Q_{201.3,\ \Sigma F})$ at $(P_{201.3})$ = 5"WC_g for the total facility**

Perform TP-201.3.

Find $(Q_{201.3,\ \Sigma F})$ at $(P_{201.3})$ = 5"WC_g for the total facility at the test conditions of TP-201.3

Warning: Do not proceed with this test procedure until TP-201.3 has been performed and $(Q_{201.3,\ \Sigma F})$ has been calculated as specified the "CALCULATING RESULTS" section.

where:

$(Q)_{201.3,\ \Sigma F}$ ≡ flow, ft^3/min

$(P)_{201.3}$ ≡ initial pressure, "WC_g

$(V)_{201.3}$ ≡ facility vapor volume, gal

$(\Delta t)_{201.3}$ ≡ elapsed time, min

$(\Delta P)_{201.3}$ ≡ absolute value of pressure change, "WC

$(P)_{201.3,\ atm}$ ≡ atmospheric pressure, "WC.

8.2 **Find $(P)_{2F}$ vs. (t) for the facility**

Find $(P)_{2F}$ vs. (t) for the facility for two weeks: 2.4 days / site

where:

$(P)_{2F}$ = pressure, "WC_g

$(T)_{2F}$ = temperature, °F

Assemble and secure the required equipment.

Perform calibrations as required.

Take and permanently record pressure readings at one minute intervals for two weeks.

Perform QA/QC as required.

8.3 **Find (T) and $[HC_{m/v}]$ vs. (t) for specified facility components**

Find (T) and $[HC_{m/v}]$ for representative episodes for vapors behind the facility components which have vapor valves:

Take samples at the following sample locations and determine values of the variables listed for each sampling location:

1F (Idle Nozzle Valves)

$[HC_{m/v}]_{1F}$ = hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{1F}$ = hydrocarbon concentration, volume fraction

$[HC_{MW}]_{1F}$ = hydrocarbon molecular weight, lb_m/lb-mole

$(T)_{1F}$ = temperature, °F

2F (Overfill Drain Valves)

$[HC_{m/v}]_{2F}$ = hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{2F}$ = hydrocarbon concentration, volume fraction

$[HC_{MW}]_{2F}$ = hydrocarbon molecular weight, lb_m/lb-mole

$(P)_{2F}$ = pressure, "WC_g

$(T)_{2F}$ ≡ temperature, °F

3F (Vent Valves)

$[HC_{m/v}]_{3F}$ ≡ hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{3F}$ ≡ hydrocarbon concentration, volume fraction

$[HC_{MW}]_{3F}$ ≡ hydrocarbon molecular weight, lb_m/lb-mole

$(T)_{3F}$ ≡ temperature, °F

$(z)_{3F-2F}$ ≡ typical height above 2F, in

$(P)_{2F-3F}$ ≡ typical pressure below $(P)_{2F}$, "WC

8.3.1 **Test representative episodes**

Unless the tester documents episodes of facility operations as more representative to the satisfaction of the ARB Executive Officer, the following episodes chosen by the ARB Executive Officer shall be tested as representative of facility operations:

(1) two hours of facility operations including the one hour of maximum dispensing to vehicle tanks,

(2) two hours of facility operations including the one hour of minimum dispensing to vehicle tanks, and

(3) two hours of facility operations following the delivery of liquid to a facility storage tank from a cargo tank.

8.3.2 **Find (T) and $[HC_{m/v}]$ vs. (t) for each episode for each sample location**

For each component sample location: 1F (Idle Nozzle Valve), 2F (Overfill Drain Valve), and 3F (Vent Valve):

(1) Assemble and secure the required equipment.

(2) Perform calibrations as required.

(3) Take samples for two hours per EPA Method 18.

(4) Perform QA/QC as required.

For each episode and sample, perform a speciated gas chromatographic analysis for hydrocarbons per EPA Method 18 and find values for $[HC_{m/v}]_{(s)}$ lb_m/ft^3 (hydrocarbon concentration, pounds per cubic foot, at sample location "s").

Warning: Do not proceed with this test procedure until the $[HC_{m/v}]_{(s)}$ have been calculated as specified the "CALCULATING RESULTS" section.

$$1.0 = \sum_{i=1}^{n} ([HC_i])_{(t,e,s)}$$

where:

"n" = the number of hydrocarbon species (or species categories).

8.3.3 **Calculate $P_{(2F-3F)}$**

Warning: Do not proceed with this test procedure until the $P_{(2F-3F)}$ have been calculated as specified the "CALCULATING RESULTS" section.

8.4 **Calculate $(P_{\Sigma F})$ vs. (t) for the facility**

Note:
$(P_{\Sigma F})_{(t)}$ ≡ zero for any system with no vent valve

Warning: Do not proceed with this test procedure until the $(P_{\Sigma F})$ have been calculated as specified the "CALCULATING RESULTS" section.

8.5 **Model values of specified variables for the facility and components**

Design and validate a model of the facility and find values for specified variables of the facility, using the model.

8.5.1 **Design the model**

Design the model so that it can:

8.5.1.1 **Reproduce (Q) vs. (P) for the total facility**

Establish (Q) vs. (P) similitude with the total facility by reproducing (Q) vs. (P) for the model at the facility test conditions of TP-201.3.

8.5.1.2 **Include components of the facility**

Include components of the facility which have vapor valves.

Secure randomly sampled units of such components and avoid testing components which are not expected to be representative of components which ultimately will be installed at new installations of the system tested.

8.5.2 **Find $(Q)_{M, \Sigma F}$ vs. $(P)_{M, \Sigma F} < 5"WC_g$**

Find $(Q)_{M, \Sigma F}$ vs. $(P)_{M, \Sigma F}$ for the total facility at other $(P)_{M, \Sigma F} < 5"WC_g$, using the model.

Volumetrically standardize results at 528°R and 1 atm:

where:

$(P)_{M, \Sigma F}$ ≡ pressure, $"WC_g$

$(Q)_{M, \Sigma F}$ ≡ flow, ft^3/min

$(T)_{M, \Sigma F}$ ≡ temperature, °F

Warning: Do not proceed with this test procedure until the $(Q)_{M, \Sigma F}$ vs. $(P)_{M, \Sigma F}$ have been standardized as specified the "CALCULATING RESULTS" section.

8.5.3 **Find $(Q)_{M, \Sigma F}$ vs. (t) for the total facility**

Find $(Q)_{M, \Sigma F}$ vs. (t) for the total facility, using the results of §8.4 and §8.5.2.

Note:

$(Q)_{M, \Sigma F}$ ≡ zero for any system with no vent valve

8.5.4 **Find the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$**

Find the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$, for the total the model.

8.5.4.1 **Find $(Q)_M$ vs. $(P)_{M,} < 5"WC_g$ for the components**

Find (Q) vs. (P) for the components at the faci valves at other $(P)_{M, \Sigma F} < 5"WC_g$, using the r

8.5.4.2 **Find $(Q)_{(M)}$ vs. (t)**

for the components

Find $(Q)_{(M)}$ vs. (t) for the components at the facility which have vapor valves, using the results of §8.4 and §8.5.4.1.

Note:		
$(Q)_{M,\,(s)}$	≡	zero for any system with no vent valve

8.5.4.3 **Calculate the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$**

Calculate the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$, for the total facility by finding (for each of the components at the facility which have vapor valves) the summation of (Q) x $[HC_{m/v}]$ x (t) divided by the summation of (Q) x (t).

Warning: Do not proceed with this test procedure until $[HC_{avg\ m/v}]_{\Sigma F}$ has been calculated as specified the "CALCULATING RESULTS" section.

$$\frac{[HC_{avg\ m/v}]_{\Sigma F}\ \#}{ft^3} = \frac{\sum_{s=1}^{n}\sum_{i=1}^{n}\left[\frac{[HC_{m/v}]_{(i,\,s)}\ \#}{ft^3} \times \frac{(Q)_{(i,\,s)}\ ft^3}{min} \times (t)_{(i,\,s)}\ min\right]}{\sum_{s=1}^{n}\sum_{i=1}^{n}\left[\frac{(Q)_{(i,\,s)}\ ft^3}{min} \times (t)_{(i,\,s)}\ min\right]}$$

where:

"s" ≡ the valve component type corresponding to sample location 1F through 3F

"i" ≡ the "i^{th}" valve of valve component type "s" at the facility

"n" ≡ the number of valves of valve component type "s" at the facility.

8.6 **Find $(HC)_{\Sigma F}$ emitted from the facility**

See "CALCULATING RESULTS" section.

8.7 **Find $(HC)_{\Sigma F}$ emissions factors for the facility**

See "CALCULATING RESULTS" section.

8.8 Find the vapor recovery efficiency (including fugitive emissions) for the facility

See "CALCULATING RESULTS" section.

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Two collocated canister samples shall be taken at each sample location to allow for the calculation of relative error.

10 RECORDING DATA

This section is reserved for future specification. More developments are expected.

11 CALCULATING RESULTS

Note: In addition to other required calculations, vapor recovery system test results shall be calculated in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

A list of symbols and nomenclature used in this procedure is provided in the "REFERENCES" section. Such symbols are used consistently in this section and in the "TEST PROCEDURE" section. Figures 1 through 3 are provided to illustrate some aspects of the procedure required below.

A detailed summary of this test procedure is provided in Figure 4.

11.1 Volume Standardization

Volumes shall be standardized as follows:

$$(V_{std})\ ft^3 = (V_m) \times \frac{(P_m)\ "WC}{407\ "WC} \times \frac{528\ ^\circ R}{(T_m)\ ^\circ R}$$

where:

(V_{std}) = volume corrected to standard conditions, ft^3

(V_m) = measured volume, ft^3

(P_m) = measured pressure, "WC

(T_m) = measured temperature, °R.

11.2 Find $(Q_{201.3,\ \Sigma F})$ at $(P_{201.3}) = 5"WC_g$ for the total facility

Find $(Q_{201.3,\ \Sigma F})$ at $(P_{201.3}) = 5"WC_g$ for the total facility at the test conditions of TP-201.3:

$$\frac{(Q)_{201.3,\ \Sigma F}\ ft^3}{min} = \frac{(V)_{201.3}}{(\Delta t)_{201.3}} \times \frac{(\Delta P)_{201.3}}{(P)_{201.3,\ atm}} \times \frac{1\ ft3}{7.481\ gal}$$

11.3 Find $[HC_{m/v}]$ vs. (t) for each episode for each sample location.

$$\frac{[HC_{m/v}]_{(s)}\ \#}{ft^3} = \sum_{i=1}^{n} \left[[HC_{v/v}]_{(i)} \times \frac{(MW)_{(i)}\ \#}{\#mole} \times \frac{\#mole}{385\ ft^3} \times \frac{407\ "WC}{(P)_{(201.2A,\ atm)}\ "WC} \times \frac{(T)_{(i)}\ ^oR}{528\ ^oR} \right]_{(s)}$$

where:

$$1.0 = \sum_{i=1}^{n} ([HC_i])_{(t,e,s)}$$

"n" = the number of hydrocarbon species (or species categories).

11.4 Calculate $P_{(2F-3F)}$

$$(P)_{2F-3F}\ "WC = (z)_{3F}\ in \times \frac{([HC_{m/v}]_{3F} - AIR\ DENSITY_{m/v})\ \#}{ft^3} \times \frac{ft^3}{62.4\ \#}$$

where:

$AIR\ DENSITY_{m/v}$ is calculated by application of the Ideal Gas Equation.

11.5 Calculate $(P_{\Sigma F})$ vs. (t) for the facility

$$(P_{\Sigma F})\ "WC = (P)_{2F}\ "WC - (P)_{2F-3F}\ "WC$$

11.6 Calculate the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$

Calculate the flow-weighted average, $[HC_{avg\ m/v}]_{\Sigma F}$, for the total facility by finding (for each of the components at the facility which have vapor valves) the summation of (Q) x $[HC_{m/v}]$ x (t) divided by the summation of (Q) x (t).

$$\frac{[HC_{avg\ m/v}]_{\Sigma F}\ \#}{ft^3} = \frac{\sum_{s=1}^{n_s}\sum_{i=1}^{n_i}\left[\frac{[HC_{m/v}]_{(i,\,s)}\ \#}{ft^3} \times \frac{(Q)_{(i,\,s)}\ ft^3}{min} \times (t)_{(i,\,s)}\ min\right]}{\sum_{s=1}^{n_s}\sum_{i=1}^{n_i}\left[\frac{(Q)_{(i,\,s)}\ ft^3}{min} \times (t)_{(i,\,s)}\ min\right]}$$

where:

"s" ≡ the valve component type corresponding to sample location 1F through 3F

"n_s" ≡ the number of valve component types at the facility

"i" ≡ the "i^{th}" valve of valve component type "s" at the facility

"n_i" ≡ the number of valves of valve component type "s" at the facility.

11.7 **Find $(HC)_{\Sigma F}$ emitted from the facility**

Find $(HC)_{\Sigma F}$ emitted from the facility during any specified time interval by finding $(Q)_{\Sigma F} \times [HC_{m/v}]_{avg} \times (t)$ for the total facility.

11.8 **Find $(HC)_{\Sigma F}$ emissions factors for the facility**

Find $(HC)_{\Sigma F}$ emissions factors for the facility for specified combinations of test parameters, e.g.: $(HC)_{\Sigma F}/(t)$, $(HC)_{\Sigma F}/(V)_{\Sigma F}$, etc.

11.9 **Find the vapor recovery efficiency (including fugitive emissions) for the facility**

11.9.1 **Find $(HC)_{\Sigma F}$ for the duration of TP-201.2**

$$m_5 = \sum_{i=1}^{n} (Q_{\Sigma F})_{(i)} \times ([HC_{m/v}]_{avg})_{(i)} \times (t)_{(i)}$$

where:

m5 ≡ fugitive mass emitted for all time intervals of TP201.2, lb_m

$t_{(i)}$ ≡ "i^{th}" time interval of TP201.2, min

Fugitive emissions shall be considered as being released from sample location (5) for the purposes of the efficiency calculation below, using the results of TP-201.2:

11.9.1.1 **Apportioned Fugitive Emissions**

Fugitive emissions of HC at a dispensing facility must be apportioned to each dispensing episode (D_e) on a basis proportional to dispensed volume.

For any D_e:

$$\Phi(D_e) = \frac{(\text{liquid volume dispensed})_e}{(\text{all liquid volume dispensed during flux of } m_5)}$$

where:

$\Phi(D_e)$ ≡ the mass fraction of fugitive emissions assigned to each dispensing episode on a proportional basis of dispensed volume.

"e" ≡ "e^{th}" dispensing episode of TP-201.2

$m_{(e,\,5)}$ ≡ $m_5 \times \Phi(D_e)$

where:

$m_{(e,\,5)}$ ≡ the mass of fugitive emissions assigned to each dispensing episode on a proportional basis of dispensed volume

11.9.1.2 **Individual Dispensing Episode Calculations**

Unless otherwise specified by the certification process, a dispensing episode starts with the removal of a nozzle from a dispenser and ends with the start of the next dispensing episode when the nozzle is removed again.

It is assumed that dispensing is into a vehicle fuel tank with a fillpipe test point and a vapor return test point, but these calculations also apply to, for example, dispensing into surrogate tanks such as 55 gallon drums.

11.9.1.3 **Mass through a Given Test Point**

For any dispensing episode:

$m_{(e,s)}$ ≡ HC mass through a given sampling location (or apportioned fugitive mass emissions)

11.9.2 **Individual Dispensing Episode Calculations**

Each dispensing episode efficiency, E_e, is calculated from the $m_{(e,s)}$:

$$E_e = \frac{m_{(e,2)} - [m_{(e,3)} + m_{(e,4)} + m_{(e,5)}]}{[m_{(e,2)} + m_{(e,1)}]} \times 100\%$$

11.10 **Find the vapor recovery efficiency (including fugitive emissions) for the facility**

For the tested vapor recovery equipment, the efficiency test result, E, for this procedure is:

$$E = \sum_{e=1}^{n} \left[\frac{E_e}{n}\right]$$

where "n" is the number of dispensing episodes.

12 REPORTING RESULTS

Note: In addition to other required results, vapor recovery system test results shall be reported in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

This section is reserved for future specification. More developments are expected.

13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

(1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.

(2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

14 REFERENCES

14.1 Symbols and Nomenclature

14.1.1 Format

Abbreviations

Abbreviations are defined to provide shorter descriptions for variables, subscripts, and units. Abbreviations used throughout this procedure for fugitive emissions paths are:

1F	=	paths through "closed" idle nozzle check valves
2F	=	paths through "closed" overfill drain valves
3F	=	paths through "closed" vent valves
4F	=	other paths

ΣF ≡ all paths

Variables

Variables are defined with an abbreviation in parentheses or square brackets:

( ) ≡ general variable

[ ] ≡ concentration variable

Subscripts

Subscripts are defined to distinguish test variables and test modes, e.g.:

$(P)_{(t,\ e,\ s)}$ ≡ value of parameter "(P)" for time interval "(t)" of testing episode "(e)" for sample location "(s)".

Any or all of these subscripts may modify a parameter and, for consistency, subscripts are defined in the order given above, e.g.:

$(P)_{(e,\ s)}$ ≡ value of parameter "(P)" for testing episode "(e)" for sample location "(s)".

$(P)_{(s)}$ ≡ value of parameter "(P)" for entire test for sample location "(s)".

Subscripts are defined to distinguish types of concentrations, e.g.:

$[(C)]_{(v/v)}$ ≡ concentration variable (volume fraction)

$[(C)]_{(m/v)}$ ≡ concentration variable (mass/volume)

$[(C)]_{(MW)}$ ≡ concentration variable (mass/mole)

Units

Units are defined and used without punctuation. The definition of each variable ends with a comma, followed by abbreviated units for such variable. Abbreviations for units used in this procedure are:

^{o}R ≡ degrees Rankine

ft ≡ feet

gal	≡	gallons
in	≡	inches
"WC	≡	inches of water column (pressure)
"WC_g	≡	inches of water column (gauge pressure)
min	≡	minutes
$385ft^3$	≡	volume of lb-mole (at P_{std} and T_{std})
lb_mf	≡	pounds (force)
lb_m	≡	pounds (mass)
lb-mole	≡	pound mole
407"WC	≡	standard pressure (P_{std})
528°R	≡	standard temperature (T_{std})

Values

Values are substituted for variables and are used without punctuation.

14.1.2 **General Test Variable**

$(P)_{201.2A,\ atm}$ ≡ atmospheric pressure, "WC

14.1.3 **Facility Test Variables**

Figures 1 and 2 illustrate some facility sample locations and fugitive emissions test variables.

Static Pressure Performance Results (TP-201.3)

$(\Delta P)_{201.3}$	≡	absolute value of pressure change, "WC
$(P)_{201.3,\ atm}$	≡	atmospheric pressure, "WC
$(\Delta t)_{201.3}$	≡	elapsed time, min
$(V)_{201.3}$	≡	facility vapor volume, gal
$(Q)_{201.3,\ \Sigma F}$	≡	flow, ft^3/min
$(P)_{201.3}$	≡	initial pressure, "WC_g

1F (Idle Nozzle Valves)

$[HC_{m/v}]_{1F}$ = hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{1F}$ = hydrocarbon concentration, volume fraction

$[HC_{MW}]_{1F}$ = hydrocarbon molecular weight, lb_m/lb-mole

$(T)_{1F}$ = temperature, °F

2F (Overfill Drain Valves)

$[HC_{m/v}]_{2F}$ = hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{2F}$ = hydrocarbon concentration, volume fraction

$[HC_{MW}]_{2F}$ = hydrocarbon molecular weight, lb_m/lb-mole

$(P)_{2F}$ = pressure, "WC_g

$(T)_{2F}$ = temperature, °F

3F (Vent Valves)

$[HC_{m/v}]_{3F}$ = hydrocarbon concentration, lb_m/ft^3

$[HC_{v/v}]_{3F}$ = hydrocarbon concentration, volume fraction

$[HC_{MW}]_{3F}$ = hydrocarbon molecular weight, lb_m/lb-mole

$(T)_{3F}$ = temperature, °F

$(z)_{3F\text{-}2F}$ = typical height above 2F, in

$(P)_{2F\text{-}3F}$ = typical pressure below $(P)_{2F}$, "WC

14.1.4 **Model Test Variables**

Figure 3 illustrates some model sample locations and test variables.

ΣF (Total Facility)

$[HC]_{M,\ \Sigma F,\ avg\ m/v}$ = hydrocarbon concentration (flow-weighted average mass/volume), lb_m/ft^3

$(P)_{M,\ \Sigma F}$ = pressure, "WC_g

$(Q)_{M,\ \Sigma F}$ = flow, ft^3/min

$(T)_{M,\ \Sigma F}$ = temperature, °F

1F (Idle Nozzle Valves)

$(P)_{M,\ 1F}$ = pressure, "WC_g

$(Q)_{M,\ 1F}$ = flow, ft^3/min

$(T)_{M,\ 1F}$ = temperature, °F

2F (Overfill Drain Valves)

$(P)_{M,\ 2F}$ = pressure, "WC_g

$(Q)_{M,\ 2F}$ = flow, ft^3/min

$(T)_{M,\ 2F}$ = temperature, °F

3F (Vent Valves)

$(P)_{M,\ 3F}$ = pressure, "WC_g

$(Q)_{M,\ 3F}$ = flow, ft^3/min

$(T)_{M,\ 3F}$ = temperature, °F

14.1.5 **Test Procedure Results**

This section is reserved for future specification. More developments are expected.

14.2 **TP-201.2**

14.3 **TP-201.3**

15 FIGURES

Figures are attached.

FIGURE 1

Fugitive Emissions Paths to the Atmosphere

FIGURE 2

Facility Fugitive Emissions Test Variables

FIGURE 3

Model Fugitive Emissions Test Variables

FIGURE 4

Summary of Test Procedure

The tester must determine values for the following variables of a dispensing facility using conventional principles of sampling and analysis:

(HC)	≡	hydrocarbon mass
$[HC]_{m/v}$	≡	hydrocarbon concentration (mass/volume)
$[HC]_{avg\ m/v}$	≡	hydrocarbon concentration (flow-weighted average mass/volume)
(P)	≡	pressure
(Q)	≡	volumetric flow rate
(T)	≡	temperature
(t)	≡	time
(V)	≡	volume.

Then, the tester must find correlated values of a model of the dispensing facility using conventional principles of modeling, sampling, and analysis.

Finally, the tester must find (HC) emissions factors for the facility for specified combinations of test parameters.

In more detail, the principle of this procedure is to:

(1) Find (Q) vs. (P) for the total facility at the test conditions specified in TP-201.3.

(2) Find (P) vs. (t) for the total facility for representative episodes.

(3) Find (T) and $[HC]_{m/v}$ for representative episodes for vapors behind the facility components which have vapor valves.

(continued on next page)

FIGURE 4 (continued)

Summary of Test Procedure

(4) Design and validate a model of the facility and find values for specified variables of the facility, using the model.

(a) Design the model so that it can:

(i) establish (Q) vs. (P) similitude with the total facility by reproducing (Q) vs. (P) for the model at the facility test conditions of TP-201.3 and

(ii) include components of the facility which have vapor valves.

(b) Find (Q) vs. (P) for the total facility at other (P), using a model of the facility.

(c) Find (Q) vs. (t) for the total facility, using the results of (2) and (4)(b).

(d) Find the flow-weighted average, $[HC]_{avg\ m/v}$, for the total facility.

(i) Find (Q) vs. (P) for the components at the facility which have vapor valves at other (P), using the model of the facility.

(ii) Find (Q) vs. (t) for the components at the facility which have vapor valves, using the results of (2) and (4)(d)(i).

(iii) Find the flow-weighted average, $[HC]_{avg\ m/v}$, for the total facility by finding (for each of the components at the facility which have vapor valves) the summation of (Q) x $[HC_{m/v}]$ x (t) divided by the summation of (Q) x (t), using the results of (3) and (4)(d)(ii).

(5) Find (HC) emitted from the facility during any specified time interval by finding (Q) x $[HC_{m/v}]_{avg}$ x (t) for the total facility.

(6) Find (HC) emissions for the facility for specified combinations of test parameters, e.g.:

(a) (HC)/(t),

(b) (HC)/(V), etc.

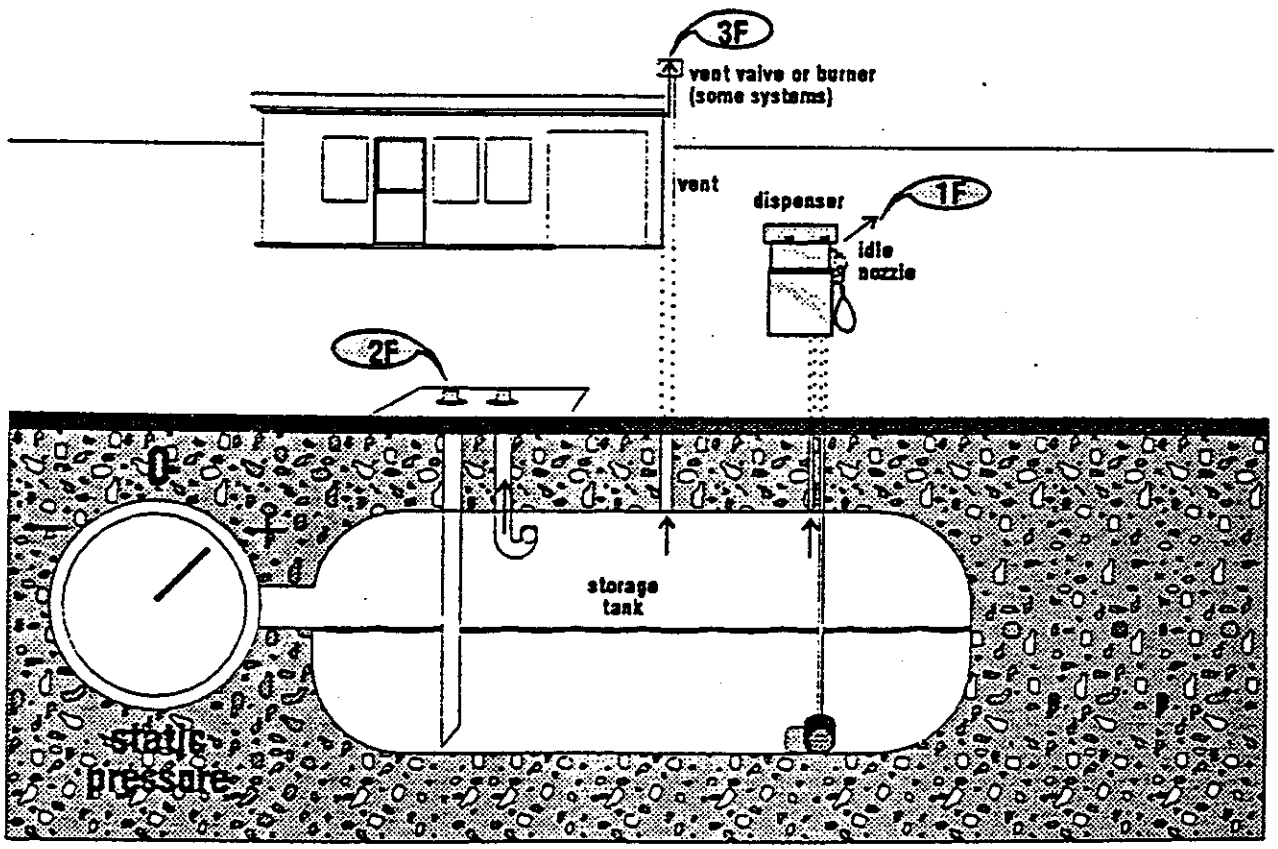
(7) Find the vapor recovery efficiency (including fugitive emissions) for the facility.

TP-201.2B
TABLE OF CONTENTS

Figure 1

Examples of Locations of Equipment to be Tested

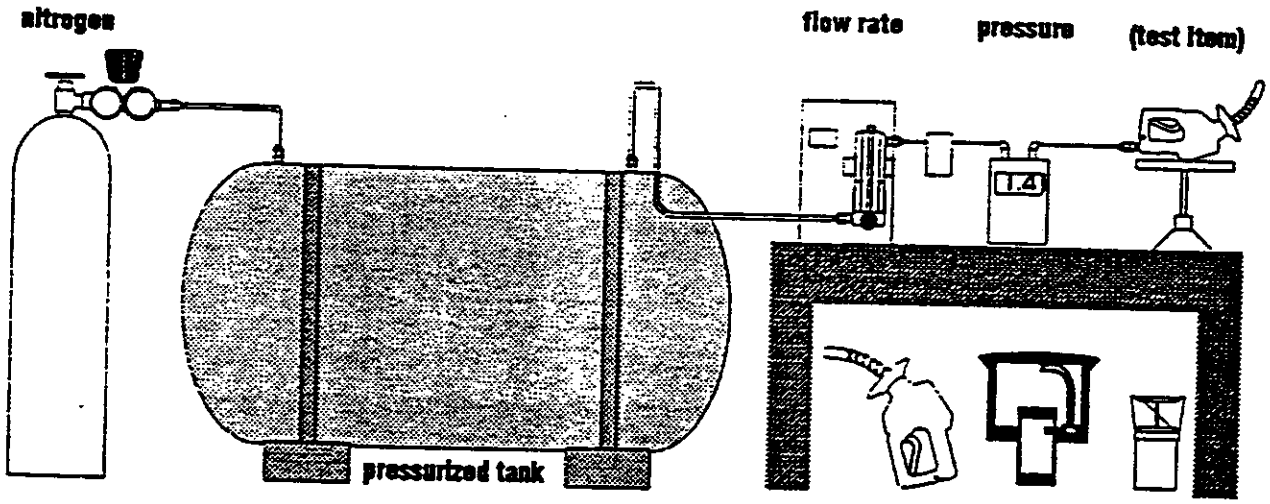
1F "closed" idle nozzle check valves
2F "closed" overfill drain valves
3F "closed" vent valves



TP 201.2B F.V.R. CORDOVA '96

FIGURE 3

Example of a Bench Test



Appendix E

TP-201.2C

DETERMINATION OF SPILLAGE OF PHASE II VAPOR RECOVERY SYSTEMS OF DISPENSING FACILITIES